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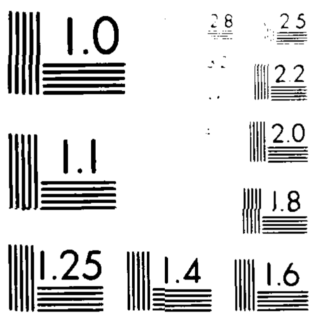
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A METEOROLOGICAL ROCKET DATA REDUCTION PROGRAM WITH AUTOMATED TEMPERATURE PROCESSING

JANUARY 1982

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The reduction of meteorological rocketsonde data at White Sands Missile Range, New Mexico, typically was done with a mixture of manual and computer techniques. The effort described by this report presents the conversion of the manual process to automated techniques, reviews the mathematical formulation of the data reduction process, and flowcharts and lists the complete data reduction program. Comparisons between manually reduced and computerized rocketsonde temperature data are presented.

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Computer Reduction of Meteorological Rocketsonde Data

INTRODUCTION

This final report provides complete documentation of software, and hardware that was developed to permit same day processing of meteorological rocketsonde data at White Sands Missile Range.

Software listings of all programs that comprise the present METROC program are included along with detailed flow charts for those programs that were specially developed to handle the digitized met data. Hardware documentation includes schematics of all electrical components, overall diagrams of interconnection wiring and the microprocessor computer program listing.

As an indication of accuracy, graphical plots of significant level temperature profiles as determined by manual methods and the computer method is included.

Since the report that covered the original data reduction program* is no longer available, this report will include some of the material from that report.

Meteorological rocket sounding systems (metrockets) have been developed to obtain upper air observations in the lowest 100 km of the atmosphere, especially that portion inaccessible to routine balloon observations, i.e., above 30 km. Some of these systems that are routinely used include a payload which consists of an atmospheric sensor, a radio transmitter for telemetering the measurements to ground tracking, receiving and recording equipment, and a radar-reflective retardation device. The atmospheric sensor normally provides temperature measurements. A radar

*A General-Purpose Meteorological Rocket Data Reduction Program by Mary Ann Seagraves, ECOM 5 ´2, August 1972

track of the payload is used to compute wind data and altitude information to correlate with the temperature measurements. Another type of metrocket payload contains only a radar target, i.e., chaff or inflatable sphere, to provide wind measurements. Other types of payloads collect specialized data for various research and development programs.

The purpose of the computer program METROC is to produce routine wind and thermodynamic data from the raw data collected from metrocket firings at White Sands Missile Range (WSMR), New Mexico, Utah Launch Complex (ULC), Green River, Utah, and other sites.

The program is written to be used on the UNIVAC 1108 computer at WSMR. It is designed so that the complete reduction of the data from each firing may be accomplished with one pass through the computer. This increases efficiency in operation by eliminating delays between the various steps of the data processing. With this approach, however, the data may not be monitored during intermediate phases of the reduction process.

The data input to METROC may be both winds and temperatures, winds only, or temperatures only. A digital tape of the radar track and telemetry is used for the computation of wind and temperature data when available. Manually reduced wind and temperature data may be input using punch cards.

The output listings are in metric units and may contain any, or all, of the following:

1. Individual wind data points
2. Summarized data for significant temperature levels, even kilometer levels, 5000 ft levels and mandatory levels
3. Listing of Meteorological Rocket Network (MRN) formatted data
4. Ozonesonde parameters

5. Wind data in English units

The summarized data listings may include layer winds averaged over 2 kilometers, corrected temperatures, pressure data computed using hydrostatic equations and a base-level point from a conjunctive raob, atmospheric density and speed of sound.

Output data cards are punched in the MRN reporting format for all runs which include wind data. Additional output cards are punched when the English units output option is selected.

An effort has been made to conform to the IRIG standards for met-rocket data reduction [1] where possible throughout the data reduction process. Smithsonian Meteorological Tables [2] was used as a source for formulae and constants.

I. MATHEMATICAL DEVELOPMENT

A. WIND COMPUTATIONS - RADAR DATA TAPE INPUT

The subroutine READTP obtains the raw data from the input tape and converts it to standard units and sampling rates. The range is converted to meters, the azimuth and elevation to radians, and the sampling rate to 10 samples per second. The sample time is referenced to time of launch. The raw data is filtered using a technique described by Avara and Miers [3]. A 117-point symmetrical filter is applied to data so that 5 consecutive samples of smoothed data are available.

Then, for each of these 5 points, the following computations are made:

Altitude corrected for earth's curvature Z_c

$$Z_c = \frac{R^2 \cos^2 E}{1.2742458 \times 10^7 + R \sin E + Z_A} \qquad (1)$$

where R = range

E = elevation angle

Z_A = station altitude.

Elevation angle corrected for earth's curvature E_c

$$E_c = \frac{E + Z_A \cos E}{1.40167038 \times 10^7 \sin E.} \tag{2}$$

East-west position, X

$$X = R \cos E_c \sin A \tag{3}$$

where A = azimuth.

North-south position, Y

$$Y = R \cos E_c \cos A. \tag{4}$$

The accelerations are then used to correct the velocities for sensor motion by a technique developed by Eddy [1]. If v is the uncorrected component velocity, then v, the corrected component velocity, is

$$v = v - \frac{a.v_z}{a_z+g} \tag{5}$$

where a = component acceleration

v_z = vertical velocity

a_z = vertical acceleration

g = gravitational acceleration.

A check is made to determine if apogee has been reached. When 12 consecutive points have been encountered for which the altitudes are decreasing, it is assumed that apogee has been reached and payload expulsion has occurred.

After apogee has been found, additional checks are made to determine whether the data is valid. If the computed vertical velocity

is positive, the data sample is rejected as invalid. Other checks may be made, but there is an option to by-pass these. (See sixth option on options data card). They are

1. The vertical velocity must be greater than -250 m/s.
2. The change in total velocity from the previous point does not exceed 30%.

The list of questionable data points is generated that consists of those samples for which

1. The change in wind direction exceeds 30° when the speed is greater than 20m/s, or
2. There is a 100% change in windspeed when the windspeed is greater than 5 m/s.

If a sample is found to be invalid, the message "DATA EXCEEDS LIMITS AT TIME XXX" is printed and that sample is not used in computing layer winds.

When a sample is valid (or questionable), it is printed and stored for use in computing layer wind data. The sample output rate is one per second.

B. WIND COMPUTATIONS - CARD INPUT

The wind data samples input on punch cards are printed and stored for subsequent use as they are read. A message is printed following each point for which the time or altitude is not sequential or for which the data exceeds certain limits. The limits for valid data are 0° to 360° for wind direction, 0 to 200 m/s for windspeed, and 0 to 250 m/s for fall velocity.

C. COMPUTATION OF LAYER WIND DATA

The altitudes of the points for which layer winds are to

be computed are first determined in the main program. The subroutine WNDAVG is called to compute the layer wind data.

An interval over which averages are to be computed is determined for each layer wind data point. Then each of the individual data points is read, and the component wind velocities are accumulated for each interval. After all the individual data points have been considered, average component winds and fall velocities are calculated, along with the time for each layer. The vector wind is determined from the component wind. Any layer which contains fewer than n points is bad-flagged, n being 6 when the wind data is computed from a radar tape and n=1 when the wind data is input on cards.

D. BASE-LEVEL POINT

A base-level point is a data point obtained from a conjunctive rawinsonde observation that was taken close in time and space to the rocketsonde observation. The data provided is atmospheric pressure and temperature at a specified altitude. By using this and rocket temperatures, thermodynamic data is computed with the hydrostatic equations. To be valid, the temperatures measured by the rawisonde and rocketsonde should agree within 2.5° at the base-level point. The program will reject all base-level points that do not have this agreement, unless a special option is selected.

Any run which contains temperature data may contain zero to 5 base-level points. If more than one base-level point is input, the one which is closest to 25 kilometers and which meets the temperature agreement criterion is used in the thermodynamic computations.

Thermodynamic computations are not made if no base-level point is input or if none meets the temperature agreement criterion and the option overriding this criterion is not selected. These computations are not done if there is no valid base-level point available which is within 2 kilometers of the lowest temperature data point.

If the override option is selected and none of the input base-level points meets the temperature agreement criterion, that point which has the best temperature agreement is used.

The base-level point which is to be used in thermodynamic computations is stored, and the rocket temperature in degrees Kelvin and the geopotential altitude are found:

$$T_k = T + 273.16 \tag{6}$$

where T_k = temperature °K

T = temperature °C

and

$$Z_p = \frac{g \times R_e \times Z}{9.8\ (R_e + Z)} \tag{7}$$

where Z_p = geopotential altitude

g = gravitational acceleration

R_e = local radius of earth

Z = geometric altitude.

E. TEMPERATURE AND THERMODYNAMIC DATA

At each step in the program where temperature and thermodynamic data are to be processed, the altitudes of the points to be output are determined first. The altitudes for the significant levels are interpolated from the individual wind data points;

when wind data is not being processed, the altitudes are read from the input data cards. Significant levels are not processed for those points at which the altitudes are not available from the wind data.

Constant-altitude layers, i.e., even kilometers, 0.5 kilometers, 500 feet, or 1000 feet, are determined by considering the highest and lowest available data, either wind data or significant temperature levels. A table of constant-altitude layers is produced for points within this span.

A table of standard constant pressures is contained within the program. It is determined which of these pressures fall within the span of available data, and then altitudes are exponentially interpolated for the constant pressure (mandatory) levels from the altitude-vs.-pressure data for the significant levels.

When wind data processing is to be included, the layer winds and fall velocity are computed after determining the layer altitudes.

Next, except for significant levels, temperatures for each layer are linearly interpolated. Subroutine THERMO is then called to do the thermodynamic computations.

First, the absolute temperatures are computed as in Equation (6).

Then, if a temperature correction is to be computed, a correction is derived based on a method developed by Krumins and Lyons and is the IRIG temperature correction [4]:

$$\Delta T(k) = T(k) - A(z) \times (Vz(k))^2 + \frac{B(z) \times (T(k+1) - T(k-1)}{t(k+1) - t(k-1)}$$

$$-C(z) + D(z) \times T(k)^4 \qquad (8)$$

where $\Delta T(k)$ = temperature correction for kth point

$T(k)$ = absolute temperature at kth point

$t(k)$ = time of kth point

$V_z(k)$ = fall velocity at kth point

and $A(z)$, $B(z)$, $C(z)$ and $D(z)$ are coefficients which vary with sensor type and altitude and $C(z)$ is also a function of time of day (night or day).

NOTE: When wind data is not processed in a run, fall velocity data is not available. Thus, no provision has been made to compute temperature corrections. However, temperature corrections which have been manually computed may be input on data cards and used in the final computations.

The temperature correction is added to the uncorrected temperatures, and the geopotential altitude is computed for each point as in Equation (7).

Atmospheric pressure is computed next, except when processing constant-press levels. Any time there is a layer of missing temperature data greater than 3 kilometers, pressure and related computations are not continued beyond that point. Pressure is computed both upward and downward from the base-level point:

$$P(k) = P\,(k-1) \times \exp \frac{Z_p\,(k-1)\;\; Z_p(k)}{14.63725 \times (T(k) - T(k-1))} \qquad (9)$$

where $P(k)$ = pressure (mb)

$Z_p(k)$ = geopotential altitude (m)

$T(k)$ = corrected absolute temperature

$k-1$ is the previous point when $k>1$, and $k-1$ is the base-level point when $k=1$.

Density is computed:

$$D = P \times 348.38/T \qquad (10)$$

$$D_1 = D \times 1.9403806 \times 10^{-6} \qquad (11)$$

where D = density (gm/cu m)

P = pressure (mb)

T = corrected absolute temperature

D_1 = density (slugs/cu ft).

Speed of sound is calculated:

$$S = 20.0544 \times \sqrt{T} \qquad (12)$$

where S = speed of sound (m/s)

T = absolute temperature

II. SYSTEM FORMULATION

In order to process high altitude meteorological data from a rocket born datasonde, the radar positional data and the significant level temperature data from the datasonde must be combined into a single profile.

The system described in this report provides a means of combining both the radar data and telemetry data into a common data bank for final processing by the UNIVAC 1108 computer into a meteorological profile.

A. OUTLINE OF TOTAL SYSTEM

The total system consists of 1)-a microprocessor system that will digitize the temperature telemetry, form the appropriate message format with this data, and transmit this data to the control record facility - this combines the temperature data but not significant level data with the radar data; 2)-software or that will process the digitized telemetry data to form a significant level

temperature profile that is consistant with the levels selected by hand. (4)

Once the data is in significant level form, the final existing computer program (ROCKET) will generate the final met profile.

B. MICROPROCESSOR SYSTEM

The microprocessor chosen was the INTEL 8080 configured as an SBC 80 single board computer. [5] This provides the user with 1024 bytes of RAM, 1024 bytes of ROM or EPROM, two 8255 parallel I/O, ports, one 8251 USART serial I/O port, EIA RS 232 logical level converters, card cage and power supply. This particular system was selected because it has the necessary hardware to do the job and was available.

C. ADDITIONAL SYSTEM REQUIREMENTS

In order to provide additional future capabilities, provisions were made to read and incorporate into the message, time data from an IRIG B time code reader, and data from four event-marker flip-flops.

These hardware items together with the analog-to-digital converter, and tri-state multiplexing chips were mounted on a general purpose prototype board. This board was inserted in the card cage to form the total system. A block diagram of this system is shown in figure 1.

D. MESSAGE FORMAT

The message format for transmission to the Central Record Facility (CRF) is composed of two 120 bit messages. The only restrictions in these messages is that the first 15 bits are fixed by the sync and station identification numbers. The message format that was used is shown in table 1. In looking at table 1 it should be noted that the time, seconds, is contained in two seperate bit

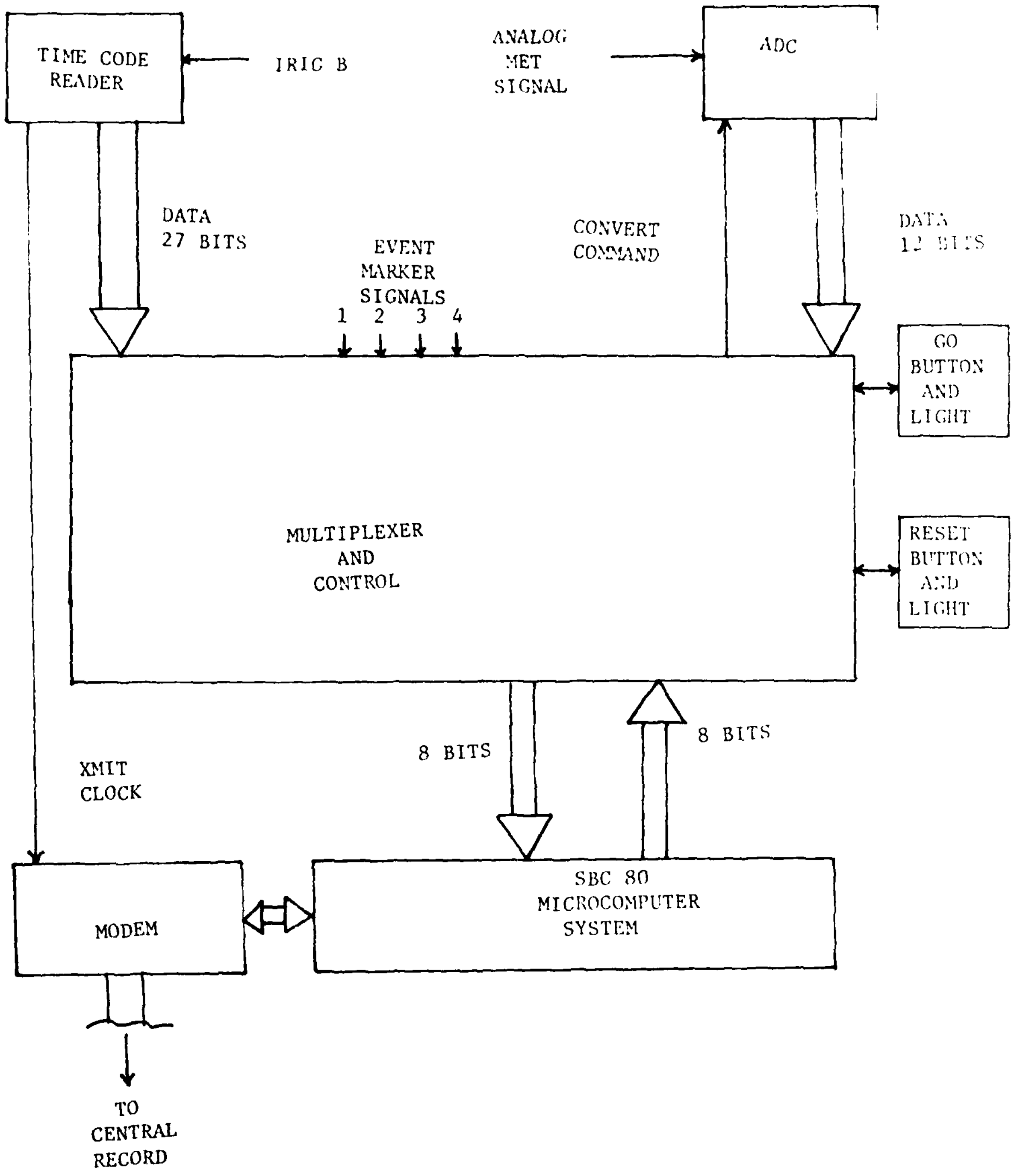


Figure 1. System block diagram.

TABLE 1. MESSAGE FORMAT FOR TRANSMISSION TO THE CENTRAL RECORD FACILITY

DATA-WORD 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Message 1	1	0	1	0	1	1	1	1	0	0	1	1	0	1	0									
	SYNC BITS								STATION ID															
Message 2	0	1	0	1	0	1	1	1	0	0	1	1	0	1	0									
	SYNC BITS								STATION ID															

DATA-WORD 2	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Message 1			2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0			2^{16}	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}				
			TIME-MILLISECONDS												TIME-SECONDS									
Message 2																								

DATA-WORD 3	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Message 1						2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	SIGN	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4
						TIME-SECONDS											MET DATA $\times 10/2^{11}$ VOLTS							
Message 2																								

DATA-WORD 4	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Message 1	2^3	2^2	2^1	2^0	#1	#2	#3	#4																
					EVENT MARKERS																			
Message 2																								

DATA-WORD 5	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Message 1																								
Message 2																								

blocks. This problem occurred because the original time code reader, for which the system was designed, had time broken down into BCD 10 h, hours, 10 min, min, 10 s, and sec. When the modems were installed, a new time code reader was also installed that had time in binary seconds and milliseconds as indicated. The new data was brought into the system by changing only the wiring to the connector. The time data, met data, and event-marker data is combined properly by the software program that generates the significant level data.

E. 8080 SOFTWARE

Figure 2 is a flow-chart of the software program that performs the data collection, message formation and transmission. The last block in figure 2 was necessary because the data when received by the CRF is complimented and the 1st bit received is treated as the most significant bit of the message. In contrast, the modem interface (USART) sends the least significant bit first. The software program for the ROM control corresponding to figure 2 is shown in table 2.

III. MICROPROCESSOR SYSTEM HARDWARE DIAGRAMS

The system is composed of six subsystems. 1) - SBC 80 microprocessors, 2) - Interface card, 3) - IRIG B time code reader-generator, 4) - Modem, 5) - Card cage, 6) - Power Supply.

Items 1, 3, 4, 5 and 6 are standard commercial units and will not be described in detail.

A. INTERCONNECTION

Figure 3 illustrates the various connection cables that are used to interconnect the various subsystems. The only connection not indicated is the backplane connection - this is made when the two cards are inserted into the card cage.

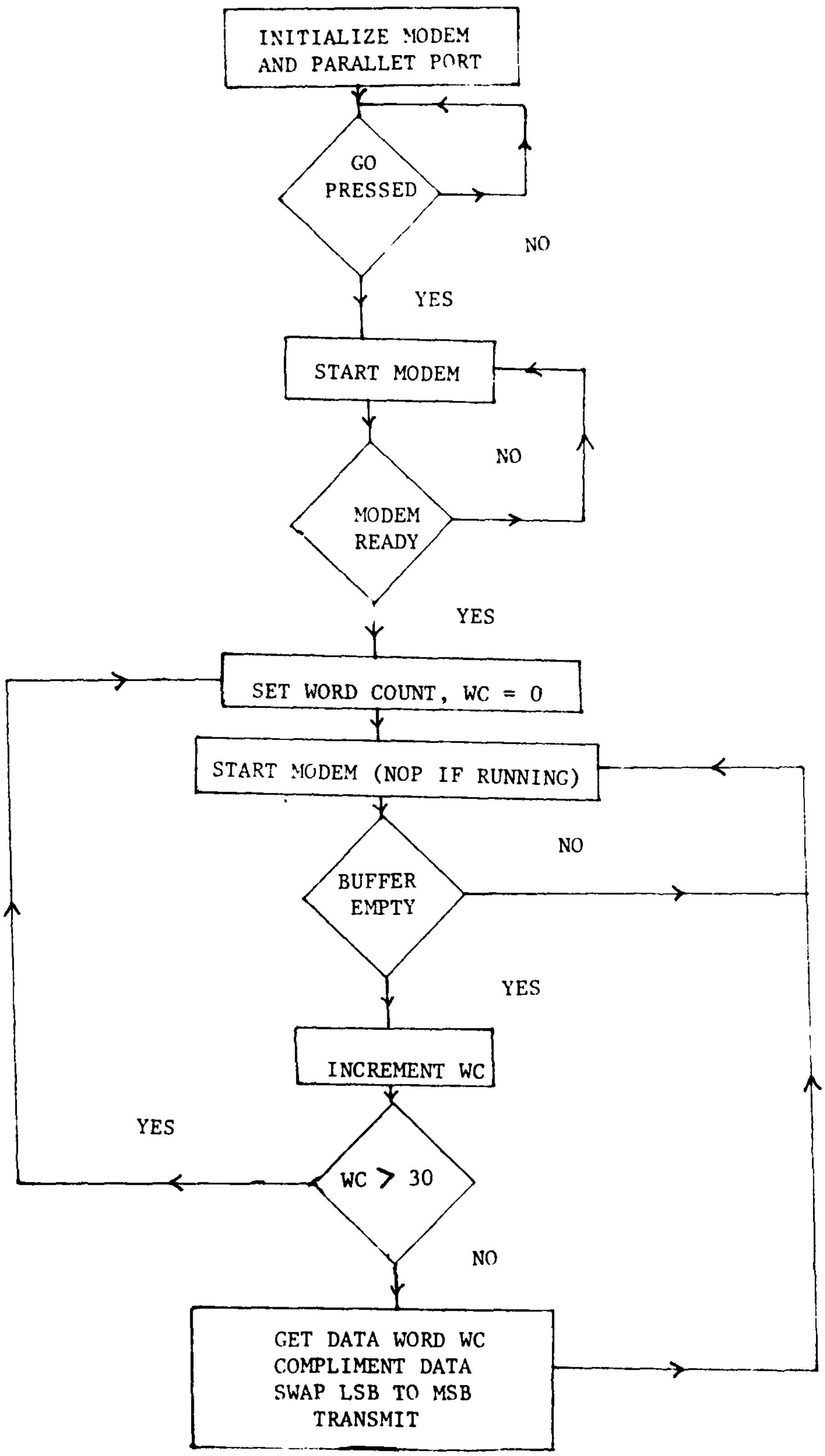


Figure 2. Flow chart for 8080 software.

```
0000                    1000 WORD     EQU 3C00H      AVAIL RAM LOCATION
0000                    1010 *
0000                    1020 *
0000                    1030          ORG 0000
0000                    1040 ***********************
0000 F3                 1050 RSET     DI             DISABLE INTERRUPTS
0001 3E 0C              1060 MODE     MVI A,014Q     SET IN SYNC MODE
0003 D3 ED              1070          OUT 355Q
0005 3E 75              1080 SYNC     MVI A,165Q     SET IN SYNC 1 WORD
0007 D3 ED              1090          OUT 355Q
0009 3E 24              1100          MVI A,044Q     SET IN SYNC 2 WORD
000B D3 ED              1110          OUT 355Q
000D 3E 12              1120 HUSH     MVI A,022Q     SET IN COMMAND WORD
000F D3 ED              1130          OUT 355Q        TO QUIET MODEM
0011 3E 82              1140 NOGO     MVI A,202Q     SET IN CONTROL WORD
0013 D3 E7              1150          OUT 347Q        FOR CONTROL PORT
0015 3E 3F              1160          MVI A,077Q     CHECK FOR GO BUTTON
0017 D3 E4              1170          OUT 344Q
0019 DB E5              1180          IN  345Q
001B E6 01              1190          ANI 001Q
001D CA 11 00           1200          JZ  NOGO       IF NOT, JUMP BACK
0020 3E 23              1210 GO       MVI A,043Q     START MODEM
0022 D3 ED              1220          OUT 355Q
0024 DB ED              1230          IN  355Q       IS MODEM READY?
0026 E6 80              1240          ANI 200Q
0028 CA 20 00           1250          JZ  GO         IF NOT, ASK AGAIN
002B 21 00 3C           1260 CLRW     LXI H,WORD     INITIALIZE WORD COUNTER
002E 36 00              1270          MVI M,000
0030 00                 1280 NEWW     NOP            (THIS REGION OF CODE HAS
0031 00                 1290          NOP            (HAS BEEN DELETED IN THE
0032 00                 1300          NOP            (ACTUAL ROM IMPLEMENTATION)
0033 00                 1310          NOP
0034 DB ED              1320          IN  355Q       TRANSMITTER BUFFER
0036 E6 01              1330          ANI 001         EMPTY?  IF NOT,
0038 CA 30 00           1340          JZ  NEWW        ASK UNTIL IT IS
003B 21 00 3C           1350          LXI H,WORD
003E 34                 1360          INR M          INCREMENT WORD COUNT
003F 3E 82              1370          MVI A,202Q
0041 D3 E7              1380          OUT 347Q       REINITIALIZE PARALLEL PORT
0043 7E                 1390          MOV A,M
0044 FE 01              1400 WRD1     CPI 001Q       WORD1 (SYNC 1)
0046 C2 4E 00           1410          JNZ WRD2
0049 3E AF              1420 SYN1     MVI A,257Q
004B C3 C8 00           1430          JMP XMIT
004E FE 02              1440 WRD2     CPI 002Q       WORD2 (SYNC 2 = ID)
0050 C2 58 00           1450          JNZ WRD3
0053 3E 34              1460 ID       MVI A,064Q
0055 C3 C8 00           1470          JMP XMIT
0058 FE 03              1480 WRD3     CPI 003Q       WORD3 (ZERO)
005A C2 61 00           1490          JNZ WRD4
005D AF                 1500 ZERO     XRA A
005E C3 C8 00           1510          JMP XMIT
0061 FE 04              1520 WRD4     CPI 004Q       WORD4 (HD,TD)
0063 C2 6B 00           1530          JNZ WRD5
0066 3E 38              1540          MVI A,070Q
0068 C3 C4 00           1550          JMP DOIT
```

TABLE 2 (cont)

```
006B FE 05          WRD5   CPI 005Q      WORD5 (UD,TH)
006D C2 75 00              JNZ WRD6
0070 3E 39                 MVI A,071Q
0072 C3 C4 00              JMP DOIT
0075 FE 06          WRD6   CPI 006Q      WORD6 (UH,TM)
0077 C2 7F 00              JNZ WRD7
007A 3E 3A                 MVI A,072Q
007C C3 C4 00              JMP DOIT
007F FE 07          WRD7   CPI 007Q      WORD7 (UM,TS)
0081 C2 89 00              JNZ WRD8
0084 3E 3B                 MVI A,073Q
0086 C3 C4 00              JMP DOIT
0089 FE 08          WRD8   CPI 010Q      WORD8 (US,DS)
008B C2 93 00              JNZ WRD9
008E 3E 3C                 MVI A,074Q
0090 C3 C4 00              JMP DOIT
0093 FE 09          WRD9   CPI 011Q      WORD9 (DIGITIZER)
0095 C2 9D 00              JNZ WD10
0098 3E 3D                 MVI A,075Q
009A C3 C4 00              JMP DOIT
009D FE 0A          WD10   CPI 012Q      WORD10 (DIGITIZER,
009F C2 A7 00              JNZ WD11        CONTACTS)
00A2 3E 3E                 MVI A,076Q
00A4 C3 C4 00              JMP DOIT
00A7 FE 10          WD11   CPI 020Q
00A9 DA 5D 00              JC  ZERO      WORDS11-15 (=ZERO)
00AC C2 B4 00       WD16   JNZ WD17
00AF 3E 57                 MVI A,127Q    WORD16 (SYNC 3)
00B1 C3 C8 00              JMP XMIT
00B4 FE 11          WD17   CPI 021Q      WORD17 (SYNC 4=ID)
00B6 C2 BC 00              JNZ WD18
00B9 C3 53 00              JMP ID
00BC FE 1F          WD18   CPI 037Q      WORDS18-30 (=ZERO)
00BE DA 5D 00              JC  ZERO
00C1 C3 2B 00              JMP CLRW      RESET WORD COUNT
00C4 D3 E4          DOIT   OUT 344Q      OUTPUT DATA TO BE READ
00C6 DB E5                 IN  345Q      INPUT ACCESSED DATA
00C8 2F             XMIT   CMA           COMPLEMENT THE DATA
00C9 47                    MOV    B,A    SAVE IT OFF TO SIDE
00CA 16 08                 MVI    D,8    ESTABLISH BYTE COUNTER
00CC AF                    XRA    A      CLEAR A REGISTER
00CD 4F                    MOV    C,A    CLEAR C REGISTER
00CE 78             SWAP   MOV    A,B    SWAP MSB'S TO LSB'S
00CF 67                    MOV    H,A    (APPARENT ERROR IN HAND CODI
00D0 17                    RAL           PUT MSB IN THE CARRY AND
00D1 47                    MOV    B,A    RESTORE THE REMAINDER
00D2 79                    MOV    A,C    FORM NEW WORD FROM OLD C
00D3 1F                    RAR           BY SHIFTING CARRY INTO THE
00D4 4F                    MOV    C,A    WORD BEING FORMED
00D5 15                    DCR    D      DECREMENT THE COUNT
00D6 C2 CE 00              JNZ    SWAP   DONE YET? NO-CONTINUE
00D9 79                    MOV    A,C    RESTORE THE WORD
00DA D3 EC                 OUT    354Q   OUTPUT REV WORD TO MODEM
00DC C3 30 00              JMP    NEWW   AND GET ANOTHER NEW WORD
00DF                ************************
```

TABLE 2 (cont)

```
PROGRAM IS 223 BYTES LONG (1) WITH 0 ERRORS DETECTED.
½ SYMBOL LISTING (Y=YES,N=NO)?
CLRW=002B DOIT=00C4 GO=0020 HUSH=000D ID=0053 MODE=0001 NEWW=0030
NOGO=0011 PSW=0006 RSET=0000 SP=0006 SWAP=00CE SYN1=0049 SYNC=0005
WD10=009D WD11=00A7 WD16=00AC WD17=00B4 WD18=00BC WORD=3C00 WRD1=0044
WRD2=004E WRD3=0058 WRD4=0061 WRD5=006B WRD6=0075 WRD7=007F WRD8=0089
WRD9=0093 XMIT=00C8 ZERO=005D
*
```

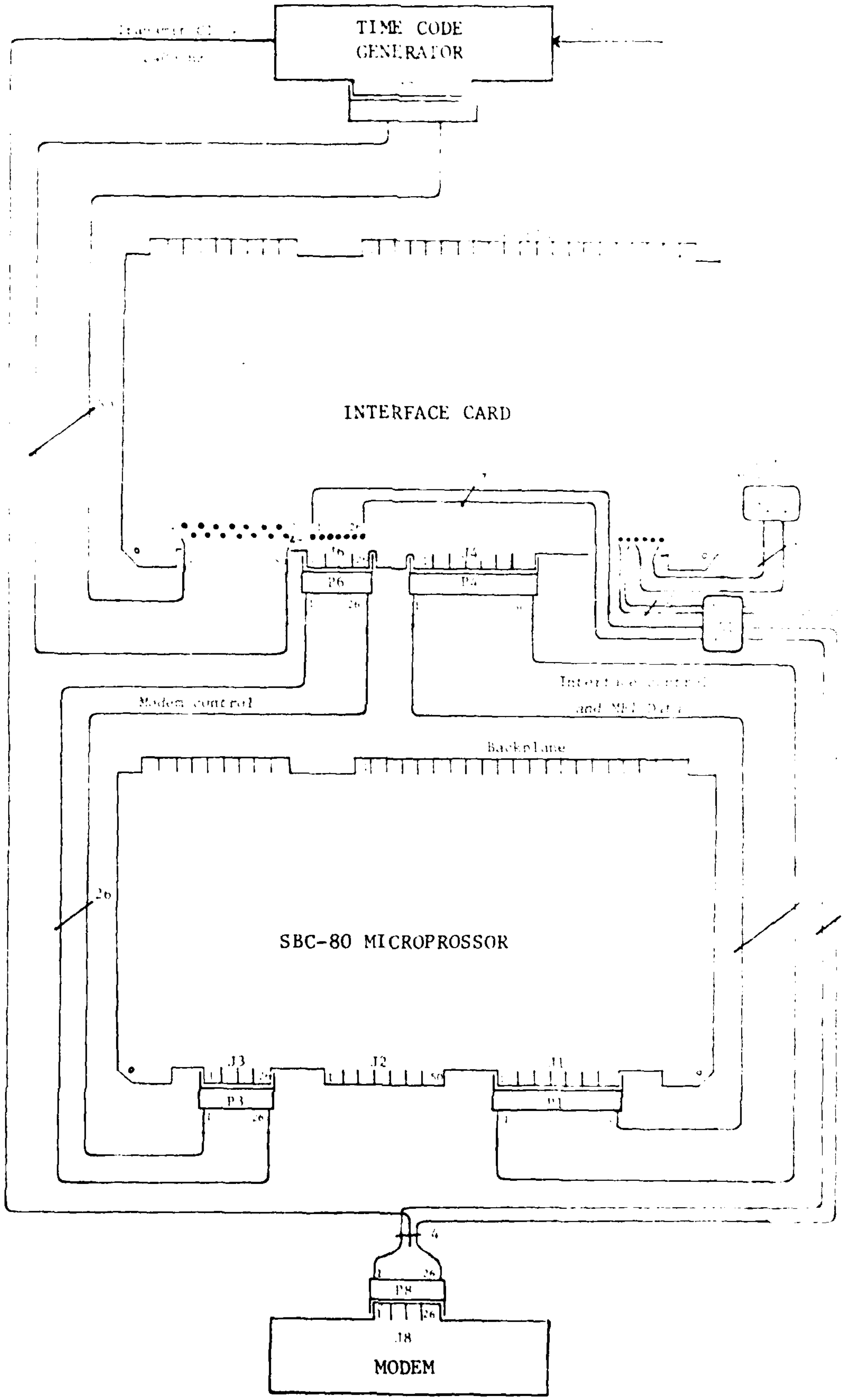


Figure 3. Microcomputer subsystem connections.

Table 3 shows the pin connections and signal identification for all connectors. TB refers to Terminal Block.

B. INTERFACE CARD

Figure 4 shows the component locations on the interface card. Each integrated circuit (IC) is indicated by a number (1 thru 17) and IC type (SN 74367, etc.).

Figure 5 illustrates the event marker logic, Go and Reset logic and the BO thru B3 data flow from the Analog to Digital Converter (A/D). The 8 bit word composed of B3, B2, B1, BO and event marker bits 1 thru 4 are gated into the microprocessor when pin 9, IC 15 is active. The numbers inside the gates indicate the IC number. The event marker outputs are set by a +5 volt pulse.

Figures 6 thru 8 show the various bits that compose the words brought into the microcomputer. Figure 9 illustrates the A/D pin connections and the multiplexer circuit for selecting the various words.

An ADC (Analog-to-Digital Converter) manufactured by Burr-Brown Research Corporation was used to digitize the met data. The met data signal was available from an on-site frequency to voltage converter.

IV. SOFTWARE

A. ORIGINAL METHODS

In order to process high altitude meteorological data from a rocket born datasonde, the positional data from the tracking radar and the significant level temperature data from the datasonde must be combined into a single profile.

TABLE 3. PIN NUMBER CONNECTIONS FOR PLUGS.

TIME CODE GENERATOR CONNECTIONS

J7	P7	Cable no.	Board pin no.
2^9 msec	l	18	17
2^8	k	17	18
2^7	j	41	42
2^6	h	40	39
2^5	f	16	15
2^4	e	15	16
2^3	d	39	40
2^2	c	38	37
2^1	b	14	13
2^0	a	13	14
2^{16} sec	C	12	11
2^{15}	F	11	12
2^{14}	H	35	36
2^{13}	J	34	33
2^{12}	L	10	9
2^{11}	M	9	10
2^{10}	N	28	27
2^9	P	4	3
2^8	R	3	4
2^7	S	27	28
2^6	T	26	25
2^5	U	2	1
2^4	V	1	2
2^3	W	49	50
2^2	X	46	45
2^1	Y	37	38
2^0	Z	36	35
	K	32	31
	A	8	7
	A	7	8
[illegible]	K	31	32
	K	30	29
	A	6	5
	A	5	6

MODEM AND ADC CONNECTIONS

Signal	J3-P3-[illegible]-J6-Board pin no.	J8	[illegible]
ADC Input	--	[illegible]	[illegible]
ADC Ground	--	[illegible]	[illegible]
TxC Output	[illegible]	[illegible]	[illegible]
DSR	[illegible]	[illegible]	[illegible]
TxD	3	[illegible]	[illegible]
CTS	[illegible]	[illegible]	[illegible]
DTR	[illegible]	[illegible]	[illegible]
RTS	[illegible]	[illegible]	[illegible]
Gnd	[illegible]	[illegible]	[illegible]
TxC Input	--	-	[illegible]

INTERFACE DATA AND CONTROL CONNECTIONS

Signal	[illegible]	[illegible]
Port 2, in		
B7	[illegible]	[illegible]
B6	[illegible]	[illegible]
B5	[illegible]	[illegible]
B4	[illegible]	[illegible]
B0,B8	9	[illegible]
B1,B9	11	[illegible]
B2,B10	13	[illegible]
B3,B11	15	[illegible]
Port 1, out		
$G2_B$	37	[illegible]
$G2_A$	39	[illegible]
B	41	[illegible]
A	43	[illegible]
C	45	[illegible]
G1	[illegible]	[illegible]

INTERFACE BACKPLANE CONNECTIONS

Signal	Pin no.
RESET	[illegible]
RESET	26
GO	28
GO Pilot	30
RESET Pilot	32

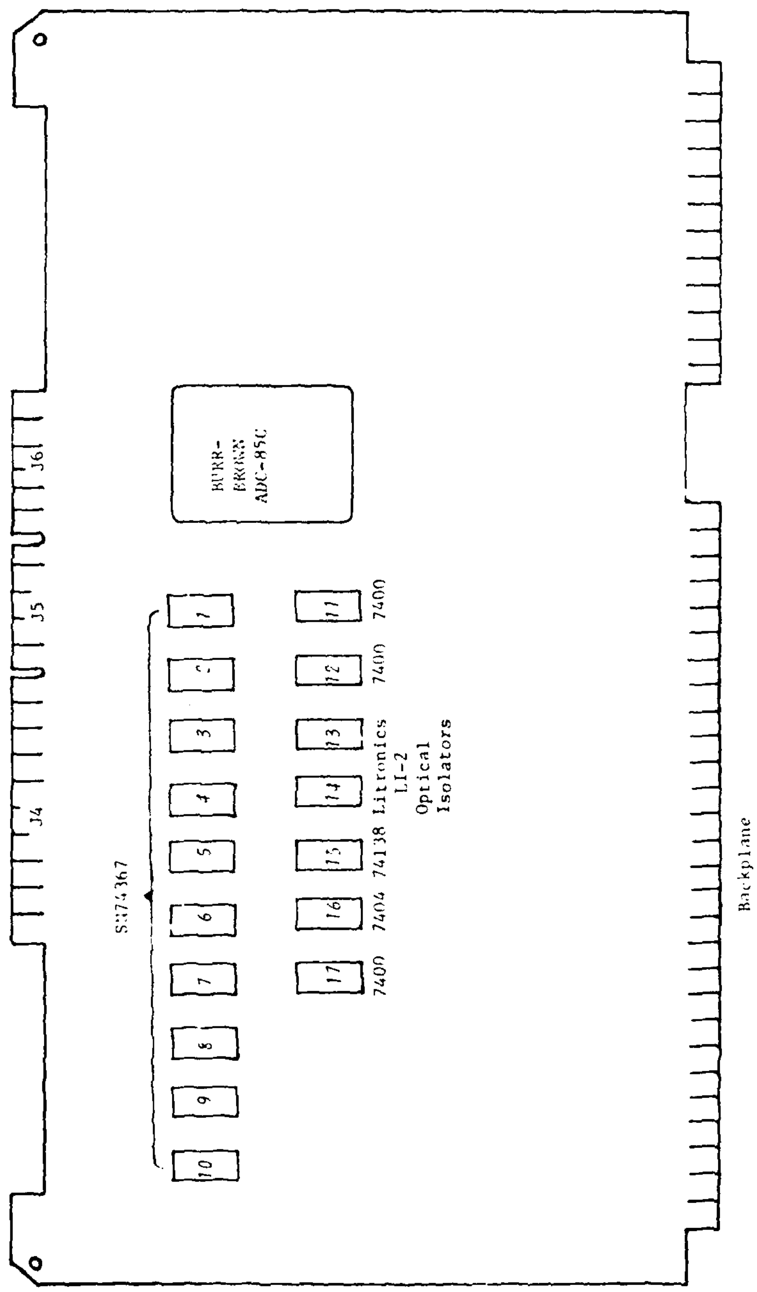


Figure 4. Component location on interface card.

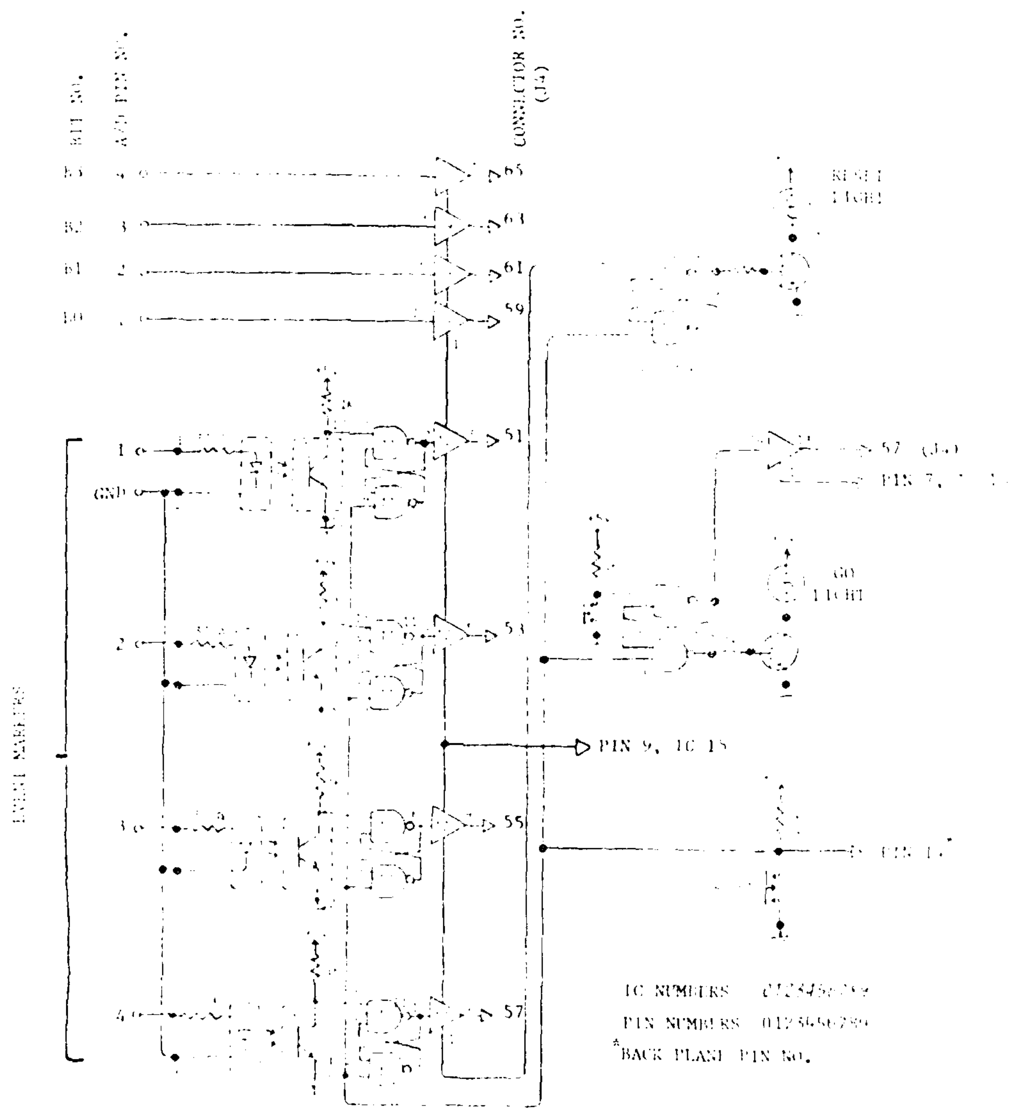


Figure 5. Event Markers, Go, Reset Diagram.

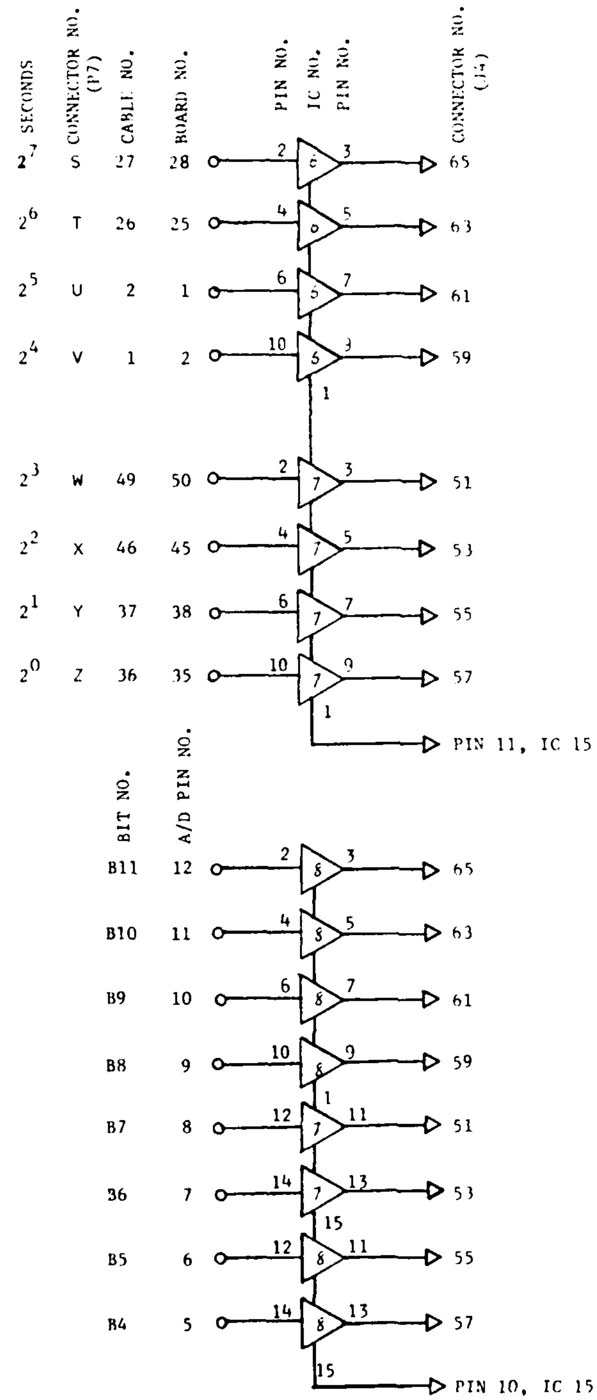


Figure 6. Data transfer diagram (A/D (B11 to B4) and 2^7 to 2^0 seconds.

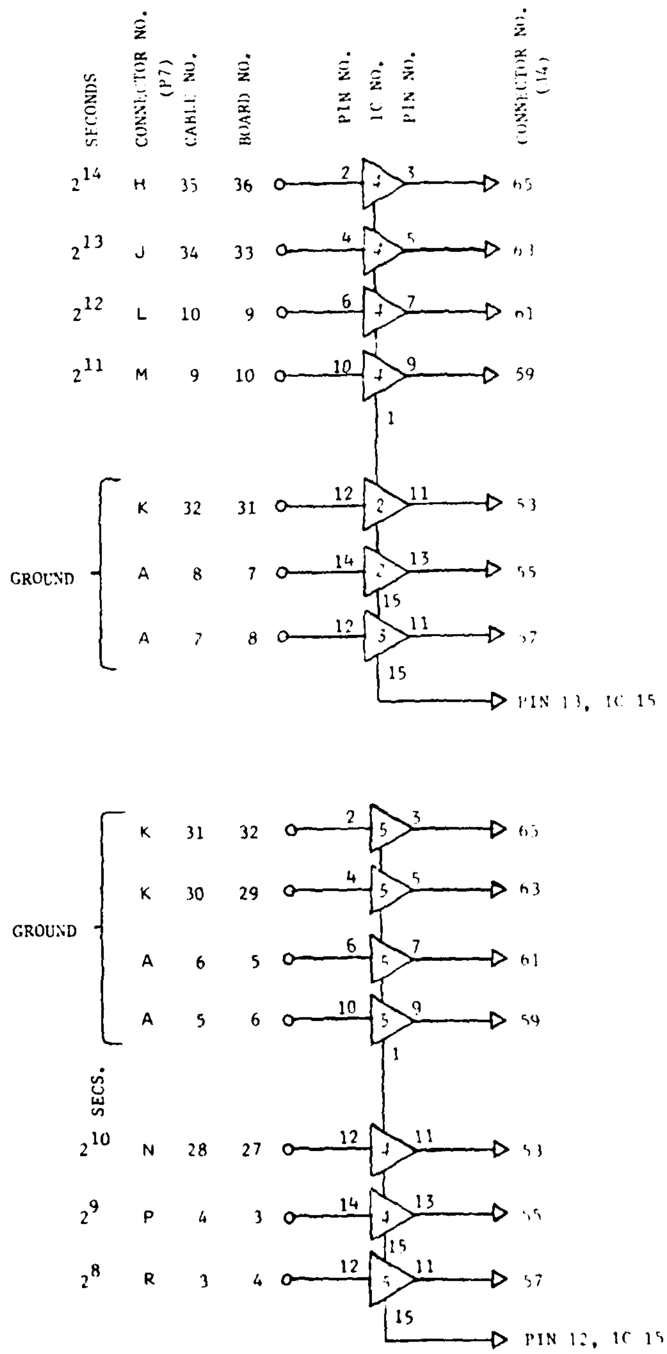


Figure 7. Data transfer diagram 2^{14} to 2^{8} seconds.

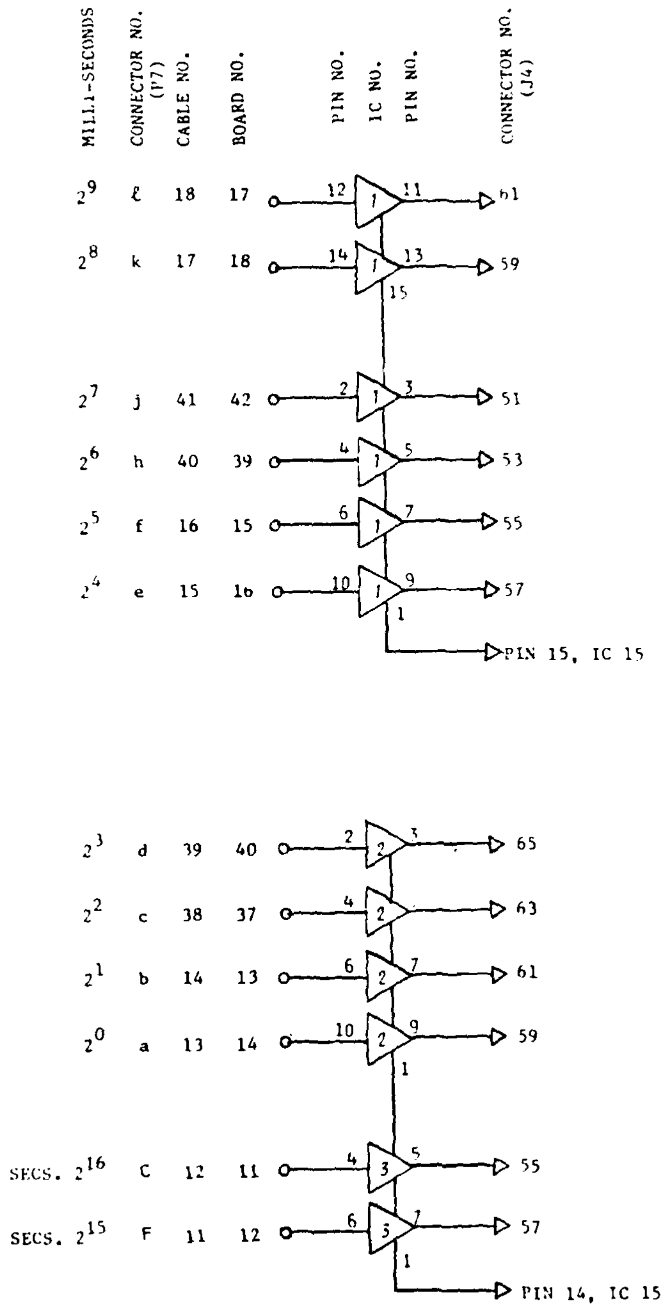


Figure 8. Data transfer diagram 2^{16} to 2^{15} seconds and 2^9 *to* 2^0 milliseconds.

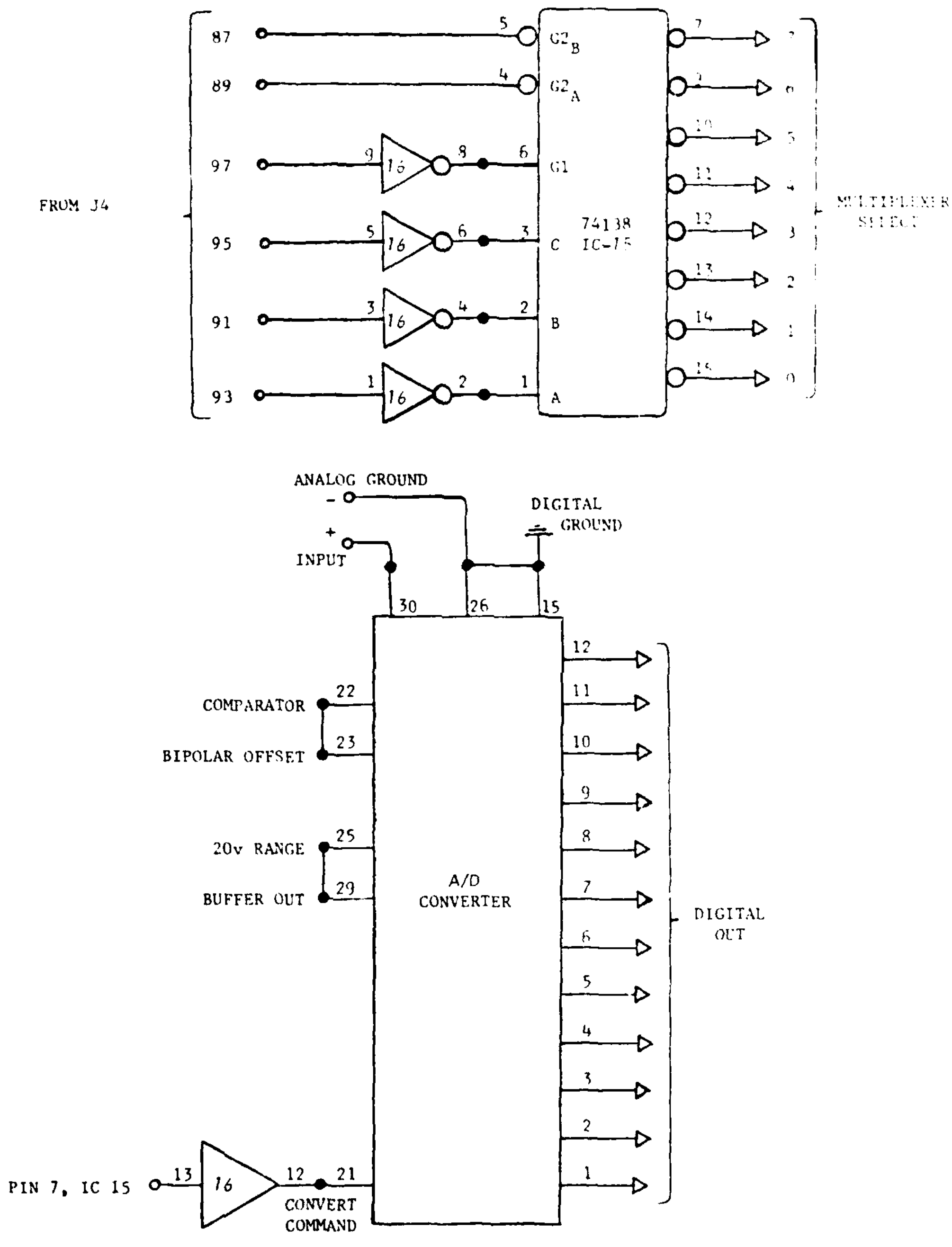


Figure 9. Diagram for word select and A/D connections.

Originally the telemetry data was processed by hand to form significant level temperature data. This data is a table of time after launch, and corresponding temperatures, which were punched on cards for the later, combining with the radar positional data.

The radar positional data of azimuth, elevation, and slant range of the datasonde are transmitted via a syncronous modem to a central record facility (CRF) and recorded on a unilog magnetic tape. Later the ROCKET program calculates a wind profile from the radar data and combines the temperature data with it from the significant temperature cards - to produce the final met profile.

B. REAL-TIME METHOD

The real-time system records simultaneously the digitized met data from the microprocessor system and the positional radar data on unilog magnetic tape.

When the unilog tape has been transferred to the 1108 system B computer system, the modified ROCKET program then processes both sets of data to form significant level temperature data, radar wind data, and ultimately a final met profile.

V. DESCRIPTION OF NEW SOFTWARE

In order to process the telemetry data to get significant level temperature data, 6 new programs were developed. A brief description of these programs and corresponding flow charts follow:

Subroutine SIGLEV I1SIG, TIME, VALUE, REFT)

As the telemetry is read from the UNILOG tape by RTDATA, SIGLEV is called to build an array of reference ordinates and significant temperature ordinates, which have passed through the filter, along with

their corresponding times. These are passed to the subroutine by the arguments TIME and VALUE. The significant temperature ordinates are selected by a call to subroutine SIGPT.

When the entire tape is read, the significant temperature ordinates are converted into ordinate-to-reference ratios. Once an ordinate-to-reference ratio is interpolated, subroutine LOKTEM converts the ratio to an actual temperature.

Finally, after the conversion of the data to a temperature array, the significant levels of this array are found within a tolerance of 2°C by subroutine SIGPT. The final significant temperatures are then printed along with their corresponding flight times, ratios, and ordinate values.

The other two calling arguments do the following: IISIG flags the subroutine for initialization and final runs, and REFT is the distinguishing level for testing whether VALUE is a reference or a temperature ordinate.

Subroutine LOKTEM (ICAL, CRATIO)

The subroutine LOKTEM has two functions which are distinguished by the argument ICAL.

The first is performed when RTDATA calls LOKTEM to read temperature calibration data from cards and to set up an interpolation scheme for temperature calculation. Once this is done, a check of the interpolation scheme is made. If the calculated values differ from the calibration values by more than 1°C the baseline calibration is rejected and a message written. The calibration ratios, values, and test are all printed on the output as well.

The second function is to perform normal temperature calculations. A temperature ordinate to reference ordinate ratio (CRATIO) is passed to the subroutine by SIGLEV as it builds the arrays. From this ratio the subroutine interpolates a temperature value from the array of stored calibration values and returns it via CRATIO.

Subroutine RTDATA

RTDATA is a general purpose tape-read routine used when processing data from a UNILOG tape. Subroutine READTP and TAPE1 use RTDATA to read FPS-16 radar data, as well as MET data for processing temperatures from telemetry. When RTDATA is called, the data in all active sub-channels for one time is stored in the CCMMON area FPS. Since the data is recorded on the tape in blocks of 20 samples per record, a new record is read once every 20 times the subroutine is called.

If temperature telemetry is being processed, RTDATA initially calls LOKTEM to perform the baseline temperature calibration. During subsequent calls, the data is filtered by calling subroutine FILTER and the calculation of temperatures is overseen by calls to SIGLEV. When an EOF indication is read, the final call to SIGLEV is made to finish the calculations and print the significant temperature levels.

When no temperature telemetry is processed from the tape, radar data is read as needed until an EOF occurs.

Subroutine SIGPT

This subroutine determines which temperature out of a string are significant - namely those points which when connected by straight lines forms a temperature profile that is within a given tolerance of the true profile.

Each temperature ordinate is taken as it comes and an array of significant temperatures is formed. After processing the ordinate values, the significant points are converted to degrees and passed through the subroutine a second time with the tolerance set at two degrees.

Subroutine FILTER

This subroutine creates a filtered-ordinate sum of six values. This is done by first selecting every eighth point, and then comparing each point to adjacent points for correlation. When an ordinate value survives the filter, it is added to the previous sum until a string of six is completed. The sum is passed to the calling program and a flag is set to indicate that a filtered ordinate value is available.

Subroutine ROCOB1

The subroutine ROCOB1 is called by the main program to perform the task of formulating and printing the ROCOB message. ROCOB1 is sent the complete array of 1-KM level wind and thermodynamic data in the COMMON area ROCOB.

VI. DESCRIPTION OF REMAINING SUBROUTINES

Subroutine MRN (NOM, ID, IW IC)

The subroutine MRN arranges the wind and thermodynamic data found in the COMMON areas WIND and TMP into the Meteorological Rocket Network reporting format [4], prints it, and punches it on data cards. Since leading zeros are to be preserved in this format, all interger fields are broken into fields of one digit so that zeros will appear when printed and punched via Fortran statements.

The variable NOM is the number of points to be processed. The variable ID equals 30 when processing significant or kilometer levels, 40 for constant-pressure levels. The variable IW is an indicator of wind input type, while IC indicates uncorrected or corrected winds.

The COMMON area MRN is used to store the data as it is broken into single-digit fields. The COMMON area SIGN is made up of alphanumeric fields containing a plus sign, a minus sign, a blank, and a nine.

Subroutine OZONE (N1, N2)

The subroutine OZONE computes and prints special thermodynamic parameters which are of significance in reference to metrockets with ozonesonde payloads. These parameters are d (ln (T)) /dZ and d(ln(P))/dZ, where T is temperature, P is pressure, and Z is altitude.

The data used in the computations is found in the COMMON areas WIND and TMP. The variables N1 and N2 are the indices of the first and last points to be used.

Subroutine QUESS

The subroutine QUESS prints the time and altitude of as many as 100 wind data samples of questionable validity. A point is considered questionable if either there is a direction shift of at least 30° when the windspeed is greater than 20 m/s, or there is a 100 percent change in speed with a windspeed greater than 5 m/s.

The times and altitudes of the questionable points are stored by the main program in the COMMON area QQ, along with the number of questionable points.

Subroutine TPREAD (IOF, IND, NEND)

The subroutine TPREAD is used to obtain raw data from digital tape and convert the times, units, and sampling rates to standard values. For each sample, the data is stored in the COMMON area TRAE. Time of the sample, TM, is in seconds referenced to lift-off time. Range, RG, is in meters while azimuth, AZ, and elevation, EL, are in radians. The standard sampling rate is 10 samples per second. An end of file indicator is found in the parameter IOF. The variable IND specifies the type of data tape being processed. NEND contains the number of reels of input tape.

When the input radar data is contained on a DR format tape, the time and sampling rate are not altered. The range is converted from yards to meters, and the azimuth and elevation are converted from mils to radians.

If the input data is on a UNILOG tape, the sampling rate is reduced from 20 samples per second to 10 samples per second by averaging each 2 consecutive points. The time is referenced to the time of launch by subtracting the lift-off time, found in the COMMON area LIFTTM, which also contains input subchannel numbers and radar numbers. The range is converted from yards to meters, and the angles are converted to radians. If two radars are to be processed in one run, the data for the second radar is converted and written on Fortran logical unit 3, while the data for the first radar is being reduced. This data is used directly, without further conversion, when processing the second radar.

The data is read from the UNILOG tape by the subroutine RTDATA and is stored in the common area FPS. The common area EOFF contains an end of file indicator.

Subroutine THERMO (TIEP, ALTIT, TIET N1, N2, NOM, IN, NCOR, GG, RE)

The subroutine THERMO computes corrected temperature, pressure, density and speed of sound for the data points found in the COMMON area WIND and stores them in the COMMON area TMP. The uncorrected temperature corresponding to each point in the array ARR is stored in the array ARC in the COMMON area TMP.

First, the temperature correction is computed by using Equation (8). The geopotential altitude is computed thus:

$$Z_p = \frac{g \times R_e \times Z}{9.8 \times (Re + Z)}$$

where Z_p = geopotential altitude

g = acceleration due to gravity

R_e = radius of the earth

Z = geometric altitude.

Except when processing constant-pressure-level data, the next step is to compute corresponding pressure. For the kth point,

$$P(k) = P(k-1) \times \exp\left[Z_p(k-1)-Z_p(k)/(14.63725x(T(k)+T(k-1)))\right]$$

where P = pressure (mb)

Z_p = geopotential altitude (m)

T = temperature (°K)

and k-1 is the previous point computed if k>1, the raob base-level point is k=1.

Then density is computed:

$$D = P \times 348.38/T$$

where D = density (gm/cu m)

P = pressure (mb)

T = temperature (°K).

Also,

$$D_1 = D \times 1.9403806 \times 10^{-6}$$

where D_1 = density (slugs/cu ft).

Speed of sound is calculated:

$$S = 20.0544 \text{ X } \sqrt{T}$$

where S = speed of sound (m/s)

T = temperature (°K).

All missing data is bad-flagged.

The variables TIEP, ALTIT, and TIET are the RAOB base-level pressure, geopotential altitude and rocket absolute temperature. The variables N1 and N2 are the indices of the first and last points for which there is temperature data, while NOM is the number of points in the array ARR. The variable IN indicates the type of data levels. The temperature correction to be used is specified by the variable NCOR. GG is the local acceleration due to gravity and RE is the local radius of the earth.

Subroutine WNDAVG (DIV, NOM, KK, JL)

The subroutine WNDAVG computes averaged wind data for an interval of size DIV. The wind data samples which are to be used in averaging were written on Fortran logical unit 13 as they were computed by the main program. As the individual samples are read, sums of the x, y, and z component velocities are computed. After all the data has been read, component velocities are computed. Vector wind and wind shear are then calculated from the component velocities. The time is obtained by interpolation. Any layer for which fewer than N points were found is bad-flagged, where N is 6 when the wind is computed from radar input

tape, and N equals 1 when the wind is input on data cards.

All computed data is stored in the array ARR in the COMMON area WIND. The variable NOM is the number of points for which wind averages are to be computed. The variable KK indicates whether the altitudes to be used are in meters or feet. The variable JL is used to indicate the wind data input type, i.e., cards or digital tape.

VII. GLOSSARY OF MNEMONICS

Main Program

A	wind direction in radians
AA	constant used in computing constant-pressure altitudes
AB	constant used in interpolating
ACC (3,10)	array used in storing acceleration prior to use of 10-point filter
ALT (200)	array containing altitudes
ALTIT	geopotential altitude of base-level point
ALTITD	geometric altitude of base-level point
APO (12)	array of altitudes used in searching for apogee
ARC (7,200)	array used to store thermodynamic data
elt 1	temperature °C
2	temperature °K
3	temperature correction
4	pressure mb)
5	density (gm/m3)
6	density (slug/cu ft)
7	speed of sound (m/s)
ARR (10,200)	array used to store layer wind data
elt 1	time (sec)
2	altitude (meters)
3	altitude (feet)
4	N-S wind component
5	E-W wind component
6	windspeed
7	wind direction
8	fall velocity
9	wind shear
10	time (min sec)
ATE	layer thickness used in computing altitude array
AZ	azimuth
BLANK	5-character field of blanks
BLANN	1-character field containing a blank

C	constant equal to .0174533
CONF	factor used to convert input altitudes to feet
CONM	factor used to convert input altitudes to meters
CON1	1.94254 converts m/s to knots
CONZ	-1.68895 converts knots to ft/sec
DEN	constant equal to change in time
DY	day of month
EL	elevation
FLAG (200)	array used to indicate missing temperature data
GG	acceleration due to gravity
IDD	data card type indicator
IND	indicates type of data being processed = -1 when processing one radar from UNILOG tape = 0 when processing 1st of 2 radars (UNILOG tape) = 1 when processing 2nd of 2 radars (UNILOG tape) =2 when processing DR format tape
INK	indicator = 0 except when missing data layer greater than 5 km
IOF	end of file indicator
IOP (11)	input options
elt 1	wind input type
2	temperature input type
3	temperature correction type
4	English units output option
5	ozone parameters output option
6	constraints on wind data option
7	corrected winds input indicator
8	use base-level-point option
9	continue temperature data indicator
10	continue thermodynamic data option
11	suppress printing 1/sec wind data option
IRAD (2)	radar number
IRDAR	radar being processed
ISC (2)	input subchannel
ITE	layer thickness used in computing altitude array
K	temperature correction type indicator
KEX	number of questionable data points
KK	index used in searching for apogee
KLM	= 0 until printing wind shear data
KYM	= 0 until first wind data card has been checked
LAST	altitude of last point in array
LFIRST	altitude of first point in array
LL	index used in Eddy correction
MINUS	1-character field containing a minus sign

MK (11)	array containing data to be output in MRN format
elt 1	altitude
2	wind direction
3	windspeed
4	N-S wind component
5	E-W wind component
6	fall velocity
7	temperature
8	temperature correction
9	power of 10 multiplied to obtain pressure
10	power of 10 multiplied to obtain density
11	speed of sound
MON	month (integer)
MONTH (24)	array containing names of months
MSIG	number of base-level points input
MUN (2)	two digits representing month
M1 (5)	five digits representing altitude
M2 (3)	three digits representing wind direction
M3 (3)	three digits representing windspeed
M4 (3)	three digits representing N-S wind component
M5 (3)	three digits representing E-W wind component
M6 (3)	three digits representing fall velocity
M7 (3)	three digits representing temperature
M8 (2)	two digits representing temperature correction
M11 (3)	three digits representing speed of sound
NEND	number of reels of input tape
NINE	1-character field containing a nine
NMP	number of significant temperature points input
NOM	number of levels in array
NOMM	number of levels in array
NOMP	number of levels in array
NOMI	number of levels in array
NZ	number of consecutive bad wind data points
N1	index of first level with temperature data
N2	index of last level with temperature data
PLUS	1-character field containing a plus sign
QUS (2,100)	array containing time and altitude of questionable wind data points
RAW (4,121)	raw radar data array
elt 1	time
2	range
3	azimuth
4	elevation
RDNUM	round number
RE	radius of the earth
RG	range
ROCKT (3)	type of rocket
SALT	station altitude

SHEAR	wind shear
SIG (4,200)	array containing data for significant levels
elt 1	corrected temperature °K
2	uncorrected temperature °C
3	pressure
4	altitude
SITE (3)	launch site
SLAT	station latitude
SLAT2	SLAT multiplied by 2
SLAT4	SLAT multiplied by 4
SLONG	station longitude
SMOT (10,5)	array containing smoothed radar data
elt 1	time
2	range
3	azimuth
4	elevation
5	X
6	Y
7	Z
8	X velocity
9	Y velocity
10	Z velocity
SM4	1-character field containing sign of N-S wind component
SM5	1-character field containing sign of E-W wind component
SS (5,6)	array containing input base-level points
elt 1	altitude
2	pressure
3	raob temperature
4	rocket temperature
5	temporary storage
STAT	station number
SZ (11)	array containing altitudes of constant-pressure levels
TEMP (200)	array containing temperatures
TFF	first time read from radar input tape
TIE	base-level rocket temperature °C
TIEP	base-level pressure
TIER	base-level raob temperature
TIET	base-level rocket temperature °K
TIME (200)	array containing times
TIMEL	time of launch (GMT)
TIMEZ	lift-off time (sec)
TIMM	time in minutes and seconds
TM	time of raw data point
TP (4,200)	array containing input temperature data
elt 1	time
2	temperature
3	altitude
4	temperature correction
TPCOR (200)	array containing temperature corrections
TT	time of wind data point

TT1	time of previous point
VD	wind direction
VD1	wind direction of previous point
VS	windspeed
VS1	windspeed of previous point
VT	total velocity
VT1	total velocity of previous point
VT2	VT1 multiplied by 1.3
VT3	VT1 multiplied by .7
VX	corrected E-W wind component
VX1	E-W wind component of previous point
VY	corrected N-S wind component
VY1	N-S wind component of previous point
VZ	vertical velocity
VZP (200)	array containing fall velocity
WGT (59)	weighting factors used in the 117-point raw data filter
WSSITE (3)	alpha field containing SMR, WSMR, NM
WSSTAT	station number for WSMR
WW (10)	weighting factors used in the 10-point filter used to smooth accelerations
XAC	smoothed X acceleration
YAC	smoothed Y acceleration
YR	year
ZAC	smoothed Z acceleration
ZF	altitude in feet
ZFIRST	altitude of first valid wind data point
ZLAST	altitude of last valid wind data point
ZZ	altitude (meters) corrected for earth's curvature
ZZ1	altitude of previous point

MRN

B	temporary storage
F9	pressure divided by power of 10
F10	density divided by power of 10
SM10	sign of exponent of 10 used with density
SM7	sign of temperature
SM8	sign of temperature correction
SM9	sign of exponent of 10 used with pressure

WINDAVE

CON	factor to convert altitude to meters
DIV	averaging interval ize
JL	= 0 if wind input is radar tape
KK	equal 2 if altitude to be used are in meters, 3 for feet
KJ	equal 0 until first point has been processed
NOM	number of averaged points

NZ	number of consecutive bad wind data points
TPREV	time of previous point
TT	time
VD	wind direction
VS	windspeed
VX	E-W wind component
VY	N-S wind component
VZ	fall velocity
ZPREV	altitude of previous point
ZZ (2)	array containing data point altitude
elt 1	meters
2	feet

RTDATA

BUFFA (3241)	input data buffer
IA (32)	array containing azimuth data by subchannel
ID (32)	array containing rate of change of range (R dot) data by subchannel
IE (32)	array containing elevation data by subchannel
IEOF	end of file indicator
IFIRST	equals 0 until initialization is complete
IMTDAT	array used when reading met data
INBUF (3241)	input data buffer
IREAD	end of data block indicator
ITQ (32)	array containing tracking mode data by subchannel
ITYPE	data type indicator
KK (6)	status array used by tape read routine
KNT	number of points of data processed in data block
T	time of data point
T1	time of met data point

TPREAD

AZM (32)	array containing azimuth data by subchannel
A1	azimuth value used in 2-point average
A2	azimuth value used in 2-point average
ELV (32)	array containing elevation data by subchannel
ENDFI1	end of file indicator
E1	elevation value used in 2-point average
E2	elevation value used in 2-point average
ID (32)	array containing radar identification by subchannel
IPAR	parity error indicator
IRDT (32)	array containing rate of change of range (R dot) by subchannel
ITQ (32)	array containing radar tracking mode by subchannel
J1	index for data for first radar processed
J2	index for data for second radar processed

RAN (32)	array containing range data by subchannel
R1	range value used in 2-point average
R2	range value used in 2-point average
TALT	time of data point
T1	time value used in 2-point average

THERMO

JJ	index of element in array ARC which corresponds to jth element in ALT array
KKK	index of first element for which pressures are computed
D	interpolated value of DZ
DZ (46,3)	array containing coefficients used in Thermo correction
RATIO	constant used in interpolation
Z (46)	array containing altitudes corresponding to coefficients AZ, BZ, CZ, and DZ

OZONE

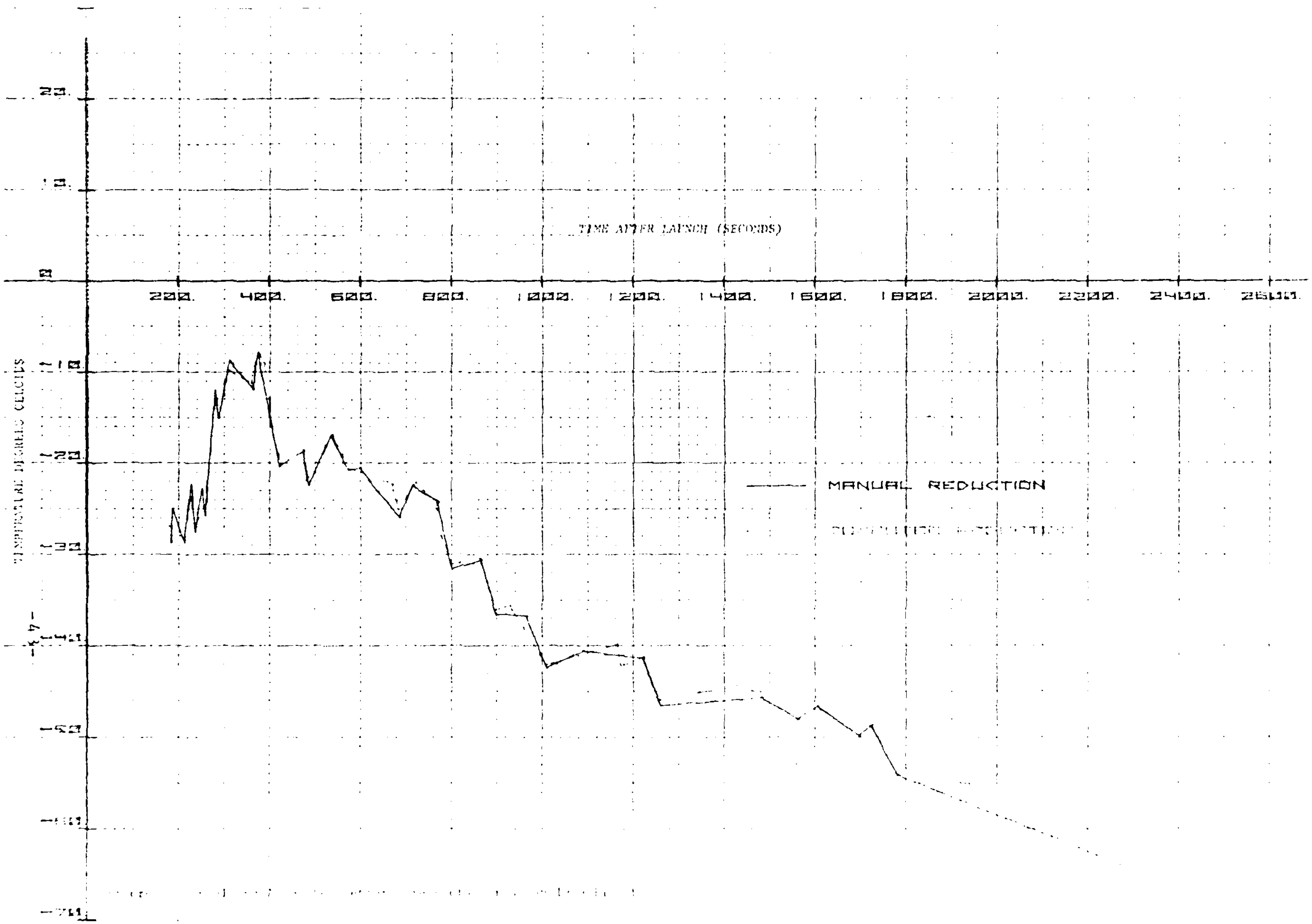
O1	d(ln P)/dz
O2	d(ln T)/dz
ZX	change in altitude from following point
ZY	change in altitude from previous point

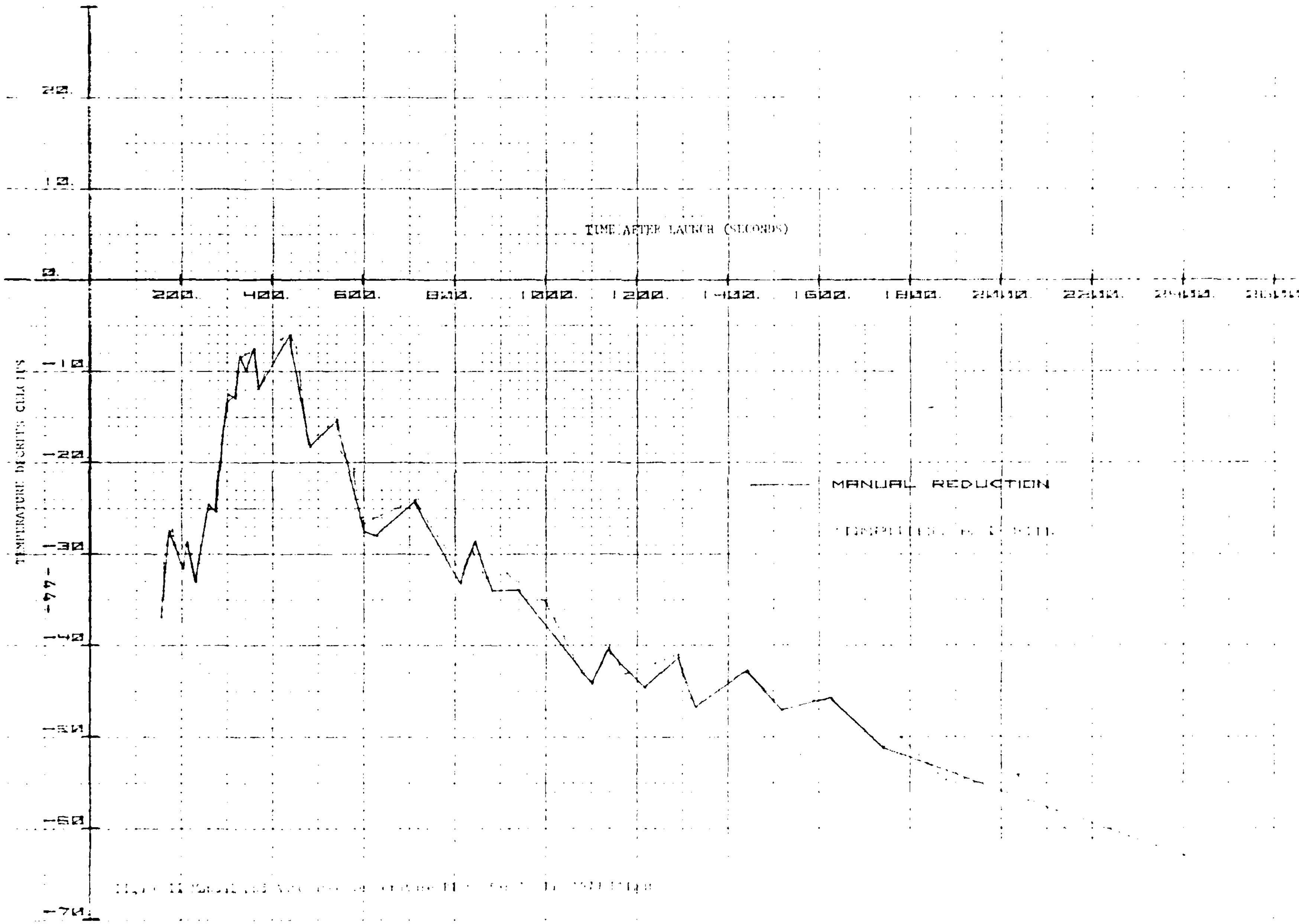
VIII. TEMPERATURE REDUCTION COMPARISON

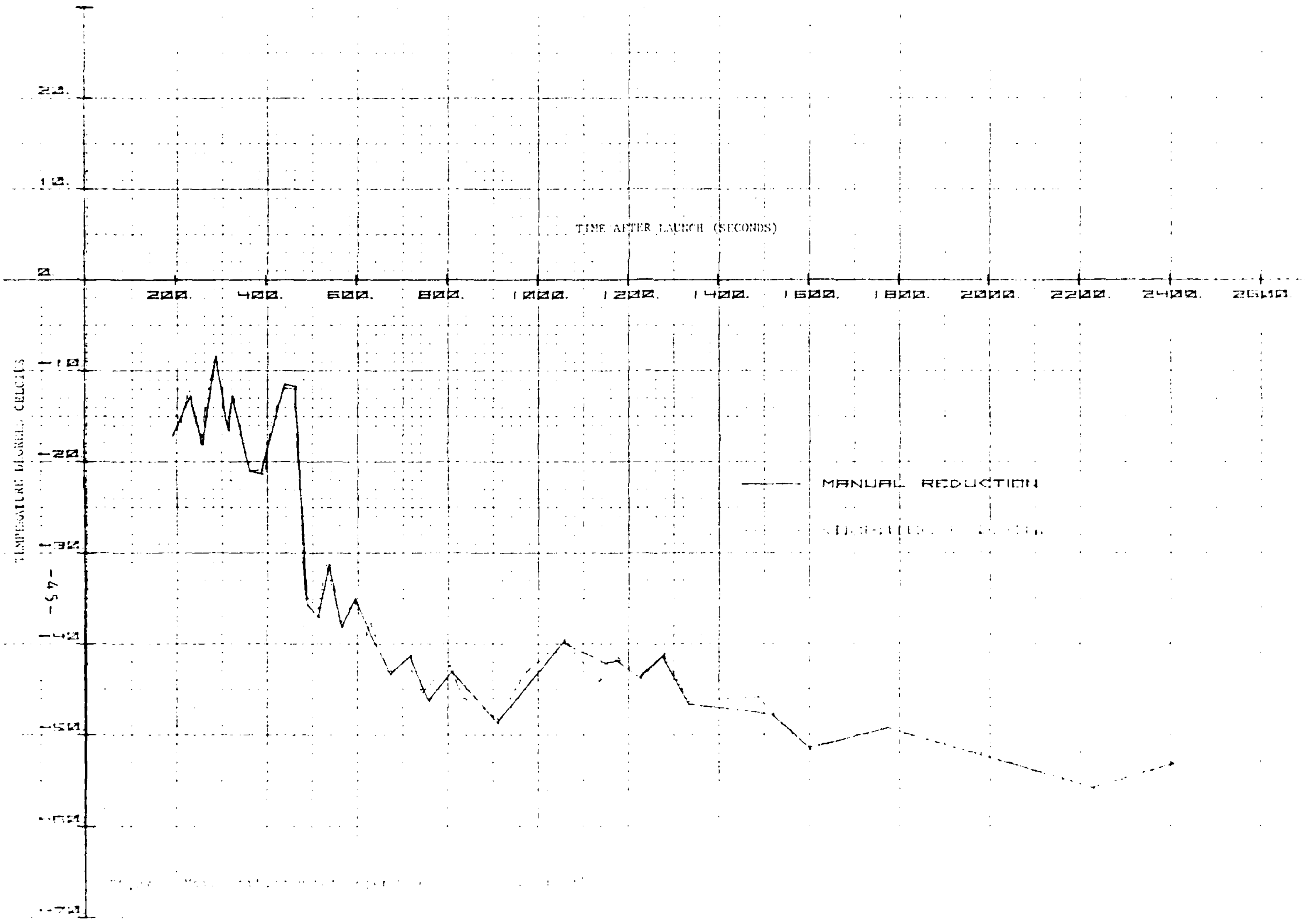
Since this report describes a system that will perform automated processing of the temperature data from a rocketsonde, an indication of the accuracy of such processing will now be made.

Because the temperature data from the automated system merely replaces the manual data with no further changes in the computer processing of the rocketsonde, only comparisons of temperatures from both systems need be made.

As an indication of accuracy between the two systems, three separate rocket flights were processed by the automated system and the temperature data compared with manual data in graphical plots. These results are shown in Figures 10, 11 and 12.


20.
10.
0
-10
-20
-30
-40
-50
-60
-70
200.
400.
600.
800.
1000.
1200.
1400.
1600.
1800.
2000.
2200.
2400.
2600.
TIME AFTER LAUNCH (SECONDS)
TEMPERATURE DEGREES CELCIUS
MANUAL REDUCTION


TIME AFTER LAUNCH (SECONDS)
TEMPERATURE DEGREES CELCIUS
MANUAL REDUCTION
20.
10.
0.
-10.
-20.
-30.
-40.
-50.
-60.
-70.
200.
400.
600.
800.
1000.
1200.
1400.
1600.
1800.


TIME AFTER LAUNCH (SECONDS)
TEMPERATURE DEGREES CELCIUS
MANUAL REDUCTION
20.
10.
0.
-10
-20
-30
-40
-50
-60
-70
200.
400.
600.
800.
1000.
1200.
1400.
1600.
1800.
2000.
2200.
2400.
2600.

In comparing the two plots in each figure, there is good agreement in some areas and not so good agreement in other areas. Since the criterion specified by the IRIG data reduction requires that the straight line segments be only within 2° of the actual curve--there curve--there is some room for difference. For example in Figure is some room for difference. For example in figure 10, the point at 2150 s and -58° yields a difference of 3.5. If the actual (strip chart) temperature were -59.75°, then the differences (manual and computer verses actual) would both be 1.75°, well with the 2nd degree tolerance.

In a further analysis for comparison, the actual raw data plots (Q5 recording) were compared with both the manual and automated output of points where the differences were large. In all cases except one, both data were within the 2° limit. The one exception was the manual reduction, which was in error due to the incorrect reading of the raw data chart.

These comparisons indicate that the automated reduction method is as good or better than the manual technique.

IX. DESCRIPTION OF DATA CARDS FOR PROGRAM

A. IDENTIFICATION CARD

The identification card is included in all runs and contains general information about the type of round and the launch location.

Col No	Format	
01-18	3A6	Rocket Type (Super Loki, etc.)
19-22	A4	Round number for the type of rocket fired during the year from that site
23-24	A2	Last two digits of year
25-26	21	Two-digit number representing month
27-28	A2	Two-digit number for day of month
29-32	A4	GMT time of launch rounded to nearest minute (leave remaining fields blank if launch site is SMR, WSMR
33-50	3A6	Name of launch site, e.g., Green River, Utah

51-55	A5	MRN station number (e.g., 72477 for Green River)
56-64	F9.4	Station latitude (e.g., 38.933 for Green River)
65-73	F9.4	Station longitude (e.g., 110.083 for Green River)
74-78	F7.2	Station altitude meters MSL (e.g., 1308 for Green River)

B. OPTIONS CARD

The options card is included in all runs and is used for selecting the options for each run.

Col No	Format	
1	I1 IOP(1)	Wind input type = (0 or blank) - no wind input, temperatures only = 1 *UNILOG radar tape used to compute winds* = 2 DR format radar tape used to compute winds = 3 winds input on cards
3	I1 IOP(2)	Temperature input type = (0 or blank) - no temperature input - winds only (no temp sense) = 1 time vs. temp input on cards (used only with winds) = 2 altitude (km) vs. temp input on cards (no wind input) = 3 altitude (ft) vs. temp input on cards (no wind input) = 4 no temperature input (sensor failure) = 5 temperature vs. time from digitized telemetry
5	I1 IOP(3)	Temperature correction type = (0 or blank) - no temp correction used = 1 Arcasonde temp correction used = 2 Loki Datasonde temp correction used (for runs with wind and temperature, for temperature-only runs, no temperature correction is computed but one may be included on the temperature data cards). = 3 Krumins' correction
7	I1 IOP(4)	English units option = (0 or blank) - no additional output ≠ (0 or blank) - additional listing and output cards containing data in English units for 1000 ft levels
9	I1 IOP(5)	Ozonesonde parameters option = (0 or blank) - no additional output ≠ (0 or blank) - data computed for .5 km and 1 kft instead of standard 1 km and 5 kft, ozonesonde parameters computed for all levels

11	I1	Ignore wind data constraints option = (0 or blank) - standard
	IOP(6)	≠ (0 or blank) - constraints on fall velocity and point-to-point wind variation ignored
13	I1	Corrected winds used on card input = (0 or blank) - assumes input wind data is uncorrected ≠ (0 or blank) - assumes input wind data is corrected
	IOP(7)	(This option is used only when winds are input on cards. The only difference in output is the columns in which the wind is put in the MRN formatted output).
15	I1	Ignore base-level criterion option = (0 or blank) - if no input base-level point has agreement of 2.5° between raob and rocket temperatures, no thermodynamic data is computed. If more than one point
	IOP(8)	meets the criterion, the one closest to 25 km is selected. ≠ (0 or blank) - if one or more points meet the above criterion, the one closest to 25 km is selected.
17	I1	Continue temperature data option ≠ (0 or blank) - if a layer of missing tem-
	IOP(9)	perature data is greater than 5 km - temperatures are considered missing for remainder of flight. ≠ (0 or blank) - temperature computations are continued regardless of existence of missing data
19	I1	Continue thermodynamic data option = (0 or blank) - if a layer of missing temperature data is greater than 3 km,
	IOP(10)	pressure, density, etc. are not computed for remainder of flight ≠ (0 or blank) - thermodynamic computations are continued regardless of existence of missing data.
21	I1	Suppress printing 1/sec wind data = (0 or blank) - standard
	IOP(11)	≠ (0 or blank) - 1/sec wind data points are not printed. The summarized output remains unchanged.

C. DIGITAL RADAR TAPE PARAMETERS

This card is included only when winds are to be computed from radar data input on a digital tape (i.e., UNILOG tape or DR formatted tape).

Col No. Format

1-3	I3	Radar number
5-6	I2	Radar subchannel (leave blank for DR tape)
8-10	I3	Radar number for 2nd Radar (leave blank for DR tape or for processing only one radar)
12-13	I2	Radar subchannel for 2nd radar
15-23	F9.3	Lift-off time in seconds (leave blank for DR tape)
25	I1	Number of reels of input tape

D. TEMPERATURE CALIBRATION DATA

These cards are included only when temperature input option and temperature vs. time from digitized telemetry, is selected. The data for these cards is taken from the calibration chart data.

1. Cards 1, 2, and 3
   Col 1 thru 70 7F10.4 format - the 21 values located in the 2nd column of the calibration sheet that shows the instrument number and thermister number for the datasonde. See Table 4.

2. Card 4
   Col 1 thru 50 5F10.3 format - the 5 values located in the last row of the sheet used for cards 1, 2 and 3 above. See Table 4.

3. Card 5
   Col 1 thru 30 3F10.3 format - the 3 values of temperature corresponding to the ratios of 0.3, 0.5, and 0.7, respectively, from the ratio vs. temperature data.

4. Card 6
   Col 1 thru 10 F10.1 format - this value is taken from the Q-5 plot and represents the ordinate corresponding to reference during the T-2 minute prelaunch plot. This value is not necessary for temperature calculations but does provide a cross reference value to the Q-5 recording.

E. WIND DATA CARDS

These cards are used to input manually reduced winds and are omitted if a radar tape is used or for a temperatures-only run. There is no program limitation on the number of wind data cards which may be included in any run.

Col No Format

1	I1	= 1 card id for wind cards
2-10	F9.6	Time from lift-off (min. sec.)
11-22	F10.2	Altitude km MSL
21-30	F10.0	Wind direction - degrees from north
31-40	F10.0	Windspeed - meters/sec

F. BASE-LEVEL POINT CARDS

These cards are used to input a base-level pressure and corresponding altitude from which thermodynamic data (pressure, density) is computed using hydrostatic equations and rocket temperatures. Zero to 5 base level points are input with each run with temperatures and the best one is selected as described for the 8th option on the option card. If no base-level point is input or if all are rejected because of temperature disagreement, then pressures and densities are not computed.

Col No	Format	
1	I1	= 2 card id for base-level point
2-10	F9.2	= Geometric altitude - km MSL (ft MSL are used if temperature altitudes are input in ft)
11-20	F10.3	Raob pressure - millibars
21-30	F10.3	Raob temperature - °C

G. TEMPERATURE DATA CARDS

These cards are used to input temperature on all runs that include temperatures when the temperature vs time - telemetry option has not been selected. As many as 200 temperature data cards may be included in any run.

Col No	Format	
1	I1	= 4 card id for temperature cards
2-10	F9.2	Time from lift-off (min. sec.)
11-20	F10.3	Temperature - °C
(Rest of card is blank except for temperatures-only runs)		
21-30	F10.3	Geometric altitude - km or ft MSL - (see 2nd option on options card)
31-40	F10.3	Temperature correction - °C

X. EXAMPLES

A. TEMPERATURE VS. TIME FROM DIGITIZED TELEMETRY

An example of how the program can be run from a terminal will now be given.

The Table 4 below shows most of the calibration data that is needed for computing temperature versus time from telemetry (IOP(2) = 5).

The data within the rectangle (Column 2) of Table 4 is input on 4I thru 6I, and the data within the rectangle (last row) of Table 4 is input on 7I. *See next page.*

The remainder of the data is as described in Section VI.

INSTRUMENT NO 21540 THERMISTOR NO 77-10-19212

21	5				
	1.0	0.9915	5572.0	5620.0	
	5.0	0.9577	5572.0	5818.0	
	10.0	0.9190	5572.0	6063.0	
	20.0	0.8509	5572.0	6548.0	
	30.0	0.7935	5572.0	7022.0	
	40.0	0.7440	5572.0	7489.0	
	50.0	0.7006	5572.0	7953.0	
	60.0	0.6623	5572.0	8413.0	
	70.0	0.6299	5572.0	8846.0	
	80.0	0.6000	5572.0	9286.0	
	90.0	0.5736	5571.0	9713.0	
	100.0	0.5506	5571.0	10118.0	
	150.0	0.4594	5571.0	12126.0	
	200.0	0.3986	5571.0	13976.0	
	300.0	0.3222	5571.0	17291.0	
	400.0	0.2766	5571.0	20139.0	
	600.0	0.2234	5571.0	24938.0	
	800.0	0.1941	5571.0	28708.0	
	1000.0	0.1757	5572.0	31722.0	
	1500.0	0.1498	5572.0	37191.0	
	2000.0	0.1359	5572.0	40986.0	
	-65.0	-50.0	-25.0	0.0	35.0
	1333.000	479.600	109.400	31.000	7.107

TABLE 4 THERMISTOR AND INSTRUMENT CALIBRATION DATA

TERMINAL COMMANDS

NOTE ALL LINES THAT HAVE > IN THEM

ARE TERMINATED WITH A RETURN ON TERMINAL

```
>@USE A.,8300*DATAFL.
READY
>@ED,I A.
CASE UPPER ASSUMED
ED 16R1W1 - (DAY - TIME)
INPUT
1I:>
EDIT
0:>TAB /  This establishes the tab character
0:>SET 19
0:>
INPUT
1I:>LOKI PARACHUTE/00137901221900
2I:>
EDIT
1:>SET 3,5,7,17,19,21
1:>
INPUT
2I:>1/5/2/1/1/1
3I:>
EDIT
```

```
2:>SET 5,8,15,25
2:>
INPUT
31:>113/1/396/68400.0/1
41:>
EDIT
3:>SET 11,21,31,41,51,61
3:>
INPUT
41:>.9915/.9577/.9190/.8509/.7935/.7440/.7006
51:>.6623/.6299/.6000/.5736/.5506/.4594/.3986
61:>.3222/.2766/.2234/.1941/.1757/.1498/.1359
71:>1333./479.6/109.4/31./7.107
81:>-44.5/-27.6/-10.
91:>90.2
101:>2 20.939/50./-55.6
111:>2 24.021/30./-49.2
121:>2 26.953/20./-46.9
131:>2  31.577/10./-37.8
141:>
EDIT
13:>LNP!
```

```
1:LOKI PARACHUTE  00587901221900
2:1 5 2 1        1 1
3:113 1  396  68400.0   1
4:.9915     .9577   .9190    .8509    .7935    .7440    .7006
5:.6623     .6299   .6000    .5736    .5506    .4594    .3986
6:.3222     .2766   .2234    .1941    .1757    .1498    .1359
7:1333.     479.6   109.4    31.0     7.107
8:-44.5     -27.6   -10.
9:90.2
10:2 20.939  50.     -55.6
11:2 24.021  30.     -49.2
12:2 26.953  20.     -46.9
13:2 31.577  10.     -37.8
```

TABLE 5 Card Images for ROCKET Program

```
0:>EXIT
LINES:  13 FIELDATA
(ANY ERRORS MADE ABOVE CAN BE CORRECTED BY USING THE OTHER EDIT COMMANDS)
>@USE B.,8300*ROCKET.
READY
>@ASG,TZ 2.,U,ACB788 (Assign unilog tape)
>@ASG,ZA PUNCHFL.
>@ASG,ZA PRINTFL.
```

```
>@BRKPT  PUNCH$/PUNCHFL

>@BRKPT  PRINT$/PRINTFL

>@HDG    (NAME NUMBER FOR OUTPUT)

>@XQT    B.METROC

>@ADD    A.

         (There will be a wait period here until a > is printed)

>@BRKPT  PUNCH$

>@BRKPT  PRINT$
```

The results of the output PRINTFL can be sent to any of the high speed printers by use of the SYM control statement or the user can examine the output with the ED processor. For this example the results of the computations up to where the wind data is printed is shown on the next pages.

OPTIONS SELECTED
WIND INPUT-UNILOG TAPE
TEMPERATURE VS TIME-TELEMETRY
HENRY (IRIG) CORRECTION FOR LOKI DATASONDE TEMPERATURES USED
CONTINUE THERMODYNAMIC COMPUTATIONS EVEN IF LAYER OF TEMP DATA MISSING
IS GREATER THAN 3KM
SUPPRESS PRINTING 1/SEC WIND DATA

LOKI PARACHUTE NUMBER 0013 LAUNCHED 22 JAN. 79, 1900 from SMR, WSMR, NM
STATION LATITUDE 32.467 LONGITUDE 106.417 ALTITUDE 1215.910 METERS
RADAR 113
GEOMETRIC ALTITUDES

LOKI CALIBRATION TAPE DATA

Ratios

.9915
.9577
.9190
.8509
.7935
.7440
.7006
.6623
.6299
.6000
.5736
.5506
.4594
.3986
.3222
.2766
.2234
.1941

.1757

.1498

.1359

CALIBRATION VALUES

1333.0000 479.6000 109.4000 31.0000 7.1070

CALIBRATION CHECK

RATIO	COMP	CHART	DIFF
.3	-44.7	-44.5	-.1
.5	-27.4	-27.6	-.2
.7	-10.0	-10.0	.0

DATA FOUND IN SUBCHANNELS

1

9

19

FIRST TIME ENCOUNTERED ON RADAR TAPE .065 SEC

LOKI PARACHUTE NUMBER 0013 LAUNCHED 22 JAN 79, 1900 FROM SMR, WSMR, NM

STATION LATITUDE 32.467 LONGITUDE 106.417 ALTITUDE 1215.910 METERS

RADAR 113

GEOMETRIC ALTITUDES

SIGNIFICANT LEVEL TEMPERATURES

TIME				
SEC	MIN:SEC	TEMP	RATIO	ORDINATE
123	2:03	31.71	.9299	83.7
127	2:07	33.99	.9355	84.2
156	2:36	.32	.7905	71.0
166	2:46	-1.21	.7786	70.0
175	2:55	-8.79	.7122	64.0
185	3:05	-8.16	.7184	64.6
195	3:15	-14.30	.6554	58.9
213	3:33	-15.76	.6392	57.4
232	3:52	-12.32	.6761	60.7
259	4:19	-17.37	.6210	55.7

279	4:39	-11.08	.6891	61.9
293	4:53	-9.30	.7072	63.6
315	5:15	-15.94	.6373	57.3
330	5:30	-13.20	.6669	60.0
367	6:07	-21.10	.5769	51.9
401	6:41	-20.86	.5802	52.2
414	6:54	-15.86	.6387	57.5
443	7:23	-12.04	.6795	61.2
465	7:45	-12.14	.6787	61.1
475	7:55	-17.46	.6202	55.8
484	8:04	-31.76	.4466	40.2
489	8:09	-34.62	.4111	37.0
516	8:36	-36.23	.3920	35.3
535	8:55	-31.42	.4500	40.5
567	9:27	-37.68	.3767	33.9
596	9:56	-35.36	.4024	36.3
623	10:23	-39.13	.3606	32.5
632	10:32	-37.77	.3753	33.9
674	11:14	-43.11	.3166	28.6
707	11:47	-41.43	.3345	30.2
744	12:24	-45.44	.2930	26.4
804	13:24	-42.51	.3224	29.1
836	13:56	-46.05	.2873	25.9
911	15:11	-48.35	.2662	24.1
974	16:14	-43.31	.3142	28.4
1058	17:38	-39.67	.3542	32.0
1135	18:55	-44.24	.3056	27.7
1176	19:36	-41.62	.3325	30.1
1227	20:27	-43.62	.3117	28.2
1278	21:18	-41.27	.3369	30.5
1333	22:13	-46.45	.2836	25.7
1485	24:45	-45.95	.2882	26.1
1600	26:40	-51.81	.2376	21.5
1783	29:43	-49.20	.2595	23.5
2223	37:03	-55.99	.2059	18.6
2403	40.03	-53.46	.2234	20.3

B. TEMPERATURE VS. TIME FROM CARDS

On page 60 is a listing of a file called 8300*LOKI.CONTROL.

This file contains information for:

1) Control of operations - Lines 1-8 and Lines 44-45
2) Data for IDENTIFICATION CARD (page 46) - Line 9
3) Data for OPTIONS CARD (page 47) - Line 10
4) Data for DIGITAL RADAR TAPE PARAMETERS (page 48) Line - 11
5) Data for BASE-LEVEL Point Cards (page 50) - Lines 12-15
6) Data for TEMPERATURE DATA CARDS (page 50) - Lines 16-43

Prior to execution of the control file, a phone call to the tape library (678-3173) requesting that tape E206 be taken to system D should be made. The execution is made by typing (the '' is the system promter)

>@ADD 8300*LOKI.CONTROL

When the system responds with '>', the file PRINT. can be examined with the ED processor or SYMmed to a printer.

Below is an explanation of the listing shown on the pages indicated:

Page	*LISTING*
61	Options selected
62	One per second wind (would continue until end of flight)
63	Thermodynamic data for input temperatures
64	Thermodynamic data for kilometer levels
65	ROCOB message
66	Plot of Wind (x,y) and Temp vs. Altitude
67	MRN 30 cards
68	MRN 30 cards (continued)
69	Thermodynamic data for 5000 feet levels
70	Thermodynamic data for mandatory levels
71	MRN 40 cards

```
@ASG,CP PRINT.
@BRKPT PRINTS/PRINT
@ASG,CP PUNCH.
@BRKPT PUNCHS/PUNCH
@ENABLE 8300*ROCKET.
@ASG,A 8300*ROCKET.
@ASG,TF 2,U,E206
@XQT 8300*ROCKET.METROC
LOKI PARACHUTE      00426109251630
1 1 3
114 02          59400.151 1
221.641           44.6       -57.8
222.860           36.9       -55.9
224.689           26.5       -52.7
225.299           25.3       -52.2
4 2.35           -26.2
4 3.01           -15.7
4 3.35           -14.7
4 3.46           -17.3
4 4.25           -08.1
4 4.46           -09.5
4 5.06           -07.1
4 5.48           -10.6
4 6.09           -04.9
4 7.34           -13.8
4 7.52           -10.2
4 8.33           -09.3
4 9.59           -21.5
4 10.37          -26.8
4 11.30          -32.6
4 13.17          -32.3
4 15.24          -36.4
4 16.37          -36.5
4 18.08          -42.2
4 21.36          -49.3
4 22.59          -48.4
4 27.55          -52.2
4 30.32          -52.9
4 32.37          -55.9
4 35.07          -56.0
4 36.02          -58.0
4 36.53          -57.4
4 38.52          -56.8
@BRKPT PRINTS
@BRKPT PUNCHS
```

```
OPTIONS SELECTED
WIND INPUT-UNILOG TAPE
TEMPERATURE VS TIME-CARD
KRUMIN CORRECTION (DAY) USED FOR ROCKET TEMPERATURES
DATA FOUND IN SUBCHANNELS--
  2
  9
 12
FIRST TIME ENCOUNTERED ON RADAR TAPE --      .000 SEC
```

LOKI PARACHUTE NUMBER 0092 LAUNCHED 25 SEP 81 1630 FROM SMR, WSMR, N M
STATION LATITUDE 32.467 LONGITUDE 106.417 ALTITUDE 1215.906 METERS RADAR 114
GEOMETRIC ALTITUDES

TIME (SEC)	ALTITUDE (MSL) (METERS)	(FEET)	WIND VELOCITY (M/SEC) -N+S	-E+W	TOTAL	DIRECTION (DEGREES)	FALL VELOCITY (M/SEC)	WIND SHEAR (MPS/M)	TIME (MIN.SEC)		
129.2	68535.	224852.	-80.5	58.8	99.7	323.84	-69.	-.130	2,09	-32.627	136.909
130.2	68463.	224616.	-88.8	63.0	108.9	324.67	-75.	-.075	2,10	-30.810	129.853
131.2	68385.	224360.	-83.0	62.5	103.9	323.02	-81.	-.198	2,11	-29.315	123.779
132.2	68302.	224087.	-66.7	60.3	89.9	317.86	-86.	-.154	2,12	-25.752	117.719
133.2	68214.	223798.	-53.2	59.1	79.5	312.01	-90.	-.078	2,13	-20.597	111.967
134.2	68121.	223493.	-46.0	59.7	75.3	307.62	-96.	-.091	2,14	-16.123	106.958
135.2	68022.	223170.	-38.2	64.0	74.5	300.80	-101.	-.076	2,15	-12.472	102.685
136.2	67920.	222834.	-31.0	60.8	68.3	297.02	-104.	-.068	2,16	-9.950	97.915
137.2	67814.	222486.	-29.5	57.8	62.8	292.94	-108.	-.047	2,17	-8.396	92.929
138.2	67705.	222128.	-19.9	55.6	59.0	289.69	-111.	-.036	2,18	-6.320	88.173
139.2	67592.	221760.	-16.3	57.6	59.9	285.83	-113.	-.060	2,19	-3.333	83.271
140.2	67478.	221384.	-11.7	62.7	63.8	280.61	-116.	-.046	2,20	1.112	79.463
141.2	67360.	220999.	-6.6	64.4	64.7	275.89	-119.	-.027	2,21	4.398	76.967
142.2	67240.	220602.	-4.4	62.0	62.2	274.07	-123.	-.006	2,22	6.390	74.712
143.2	67115.	220195.	-4.1	62.8	62.9	273.74	-125.	-.017	2,23	8.896	70.976
144.2	66990.	219782.	-6.1	63.7	64.0	275.45	-126.	-.012	2,24	12.377	65.781
145.2	66863.	219368.	-6.6	62.3	62.6	276.06	-126.	-.045	2,25	15.487	61.225
146.2	66736.	218952.	-5.6	59.3	59.5	275.39	-128.	-.034	2,26	16.216	58.012
147.2	66608.	218529.	-4.8	55.0	55.2	275.00	-130.	-.010	2,27	16.456	55.073
148.2	66477.	218101.	-5.2	53.8	54.0	275.52	-131.	-.019	2,28	17.794	51.919
149.2	66346.	217669.	-3.9	51.7	51.8	274.28	-132.	-.041	2,29	19.487	49.136
150.2	66213.	217235.	-2.4	46.4	46.5	272.97	-132.	-.050	2,30	20.472	46.899
151.2	66081.	216800.	-1.1	39.9	39.9	271.61	-133.	-.032	2,31	19.780	44.585
152.2	65948.	216363.	-1.1	35.6	35.6	271.77	-133.	-.011	2,32	19.424	41.938
153.2	65814.	215925.	-.6	34.2	34.2	271.05	-134.	-.030	2,33	20.625	39.258
154.2	65680.	215486.	.9	37.9	37.9	268.58	-134.	-.011	2,34	22.412	37.070
155.2	65546.	215046.	.8	36.4	36.4	268.78	-134.	-.022	2,35	22.938	34.922
156.2	65413.	214609.	.5	33.5	33.5	269.10	-133.	-.013	2,36	22.467	32.920
157.2	65280.	214174.	1.1	35.1	35.1	268.24	-133.	-.043	2,37	23.358	31.421
158.2	65148.	213739.	1.9	40.7	40.7	267.34	-133.	-.021	2,38	26.260	30.088
159.2	65015.	213305.	.7	43.2	43.2	269.02	-132.	-.030	2,39	28.491	28.164
160.2	64884.	212874.	-.9	39.6	39.6	271.23	-131.	-.060	2,40	28.133	26.079
161.2	64754.	212446.	-1.7	31.9	31.9	273.00	-130.	-.054	2,41	25.579	24.199
162.2	64623.	212019.	-3.5	25.0	25.3	277.98	-130.	-.038	2,42	23.485	22.436
163.2	64493.	211592.	-7.8	22.6	23.9	289.14	-129.	-.030	2,43	23.247	19.341
164.2	64365.	211171.	-10.1	25.7	27.6	291.33	-128.	-.030	2,44	25.380	16.562
165.2	64238.	210754.	-8.4	29.3	30.4	286.10	-127.	-.019	2,45	27.434	15.723
166.2	64111.	210339.	-6.0	28.7	29.3	281.89	-127.	-.040	2,46	27.591	15.845

LOKI PARACHUTE   NUMBER UC42 LAUNCHED 25 SEP 81 1630 FROM SMR, WSMR, N M
STATION LATITUDE   32.467 LONGITUDE   106.417 ALTITUDE 1215.906 METERS   RADAR 114
GEOMETRIC ALTITUDES
WIND DATA AVERAGED OVER 2 KM LAYER

THERMODYNAMIC DATA FOR SIGNIFICANT LEVELS
BASE LEVEL PRESSURE 25.30 MB, ROCKET TEMPERATURE-52.42 RAOB TEMPERATURE-52.20
GEOMETRIC ALTITUDE 25299. METERS GEOPOTENTIAL 25187. METERS

TIME	ALTITUDE (MSL)		WIND VELOCITY (M/SEC)			WIND DIRECTION	FALL VELOCITY	WIND SHEAR	TEMPERATURE (DEGREES)		CORR.	PRESSURE	DENSITY		SPEED OF SOUND
(SEC)	(KM)	(FEET)	-N+S	-E+W	TOTAL	(DEGREES)	(M/SEC)	(MPS/M)	(CENT)	(KEL)		(MB)	(GRAMS/CU.M.)	(SLUGS/CU.FT.)	(M/SEC)
155.0	65.57	215119.	-1.0	39.0	39.0	271.4	-132.	.006	-39.4	233.8	-13.2	,103	.154	.2979-06	306.61
181.0	62.32	204466.	-9.2	22.7	24.5	292.0	-114.	.007	-24.9	248.2	-9.2	,162	.227	.4403-06	315.96
215.0	58.84	193031.	2.4	2.3	3.3	223.4	-91.	.008	-21.2	251.9	-6.5	,258	.357	.6920-06	318.32
226.0	57.87	189859.	-.7	8.9	8.9	274.7	-86.	.006	-22.6	250.5	-5.3	,293	.408	.7917-06	317.42
265.0	54.81	179834.	16.3	.8	16.3	182.7	-71.	.009	-11.7	261.4	-3.6	,438	.584	.1132-05	324.24
286.0	53.40	175186.	3.5	-.3	3.6	175.7	-65.	.002	-12.8	260.3	-3.3	,525	.703	.1365-05	323.57
306.0	52.14	171071.	1.5	1.4	2.1	223.8	-60.	.003	-10.1	263.1	-3.0	,617	.817	.1586-05	325.27
348.0	49.85	163540.	-2.8	-3.4	4.4	51.2	-51.	.003	-12.9	260.2	-2.3	,829	1.110	.2153-05	323.52
369.0	48.83	160188.	.5	-2.2	2.3	103.1	-47.	.003	-7.0	266.2	-2.1	,944	1.236	.2399-05	327.19
454.0	45.22	148356.	6.4	-11.3	13.0	119.6	-39.	.001	-15.5	257.7	-1.7	1,501	2.029	.3937-05	321.93
472.0	44.54	146138.	5.5	-11.0	12.3	116.4	-37.	.005	-11.6	261.6	-1.4	1,638	2.182	.4234-05	324.35
513.0	43.13	141495.	-.9	-10.1	10.1	85.1	-32.	.001	-10.7	262.5	-1.4	1,965	2.608	.5061-05	324.90
599.0	40.60	133211.	-2.0	-10.8	11.0	79.6	-27.	.004	-22.8	250.4	-1.3	2,739	3.810	.7393-05	317.34
637.0	39.63	130022.	-5.5	-9.6	11.1	60.2	-25.	.001	-28.0	245.2	-1.2	3,126	4.442	.8618-05	314.02
690.0	38.39	125950.	-5.9	-8.6	10.5	55.6	-22.	.002	-33.6	239.5	-1.0	3,715	5.403	.1048-04	310.39
797.0	36.19	118736.	-8.0	-4.4	9.2	28.9	-19.	.006	-33.2	240.0	-.9	5,063	7.349	.1426-04	310.68
924.0	34.01	111569.	4.0	-6.3	7.5	122.8	-16.	.004	-37.2	236.0	-.8	6,902	10.189	.1977-04	308.08
997.0	32.88	107884.	4.2	-10.9	11.7	111.3	-14.	.005	-37.2	235.9	-.7	8,107	11.970	.2323-04	308.04
1088.0	31.67	103893.	-1.3	-13.7	13.8	84.5	-13.	.002	-42.9	230.3	-.7	9,670	14.631	.2839-04	304.31
1296.0	29.19	95778.	-1.0	-9.5	9.6	84.3	-11.	.001	-49.9	223.2	-.6	13,985	21.824	.4235-04	299.64
1379.0	28.35	93018.	-1.6	-10.0	10.1	80.9	-10.	.002	-49.0	224.2	-.6	15,882	24.681	.4789-04	300.27
1675.0	25.68	84245.	-.9	-5.8	5.9	81.5	-8.	.001	-52.7	220.4	-.5	23,865	37.716	.7318-04	297.75
1722.5	25.30	83002.	-1.3	-5.5	5.7	77.1	-8.	.002	-52.9	220.2	-.5	25,296	40.016	.7765-04	297.61
1832.0	24.[illegible]8	80319.	-1.3	-3.9	4.1	71.5	-7.	.003	-53.4	219.8	-.5	28,692	45.486	.8826-04	297.29
1957.0	23.60	77438.	1.0	-3.9	4.0	104.0	-7.	.000	-56.4	216.8	-.5	32,882	52.850	.1025-03	295.25
2107.0	22.64	74279.	1.3	-4.2	4.4	106.7	-6.	.003	-56.5	216.7	-.5	38,226	61.467	.1193-03	295.18
2162.0	22.31	73206.	.3	-4.0	4.0	94.5	-6.	.004	-58.5	214.7	-.5	40,244	65.316	.1267-03	293.82
2213.0	22.00	72195.	-.9	-3.5	3.6	75.0	-6.	.003	-57.9	215.3	-.5	42,249	66.374	.1327-03	294.24
2332.0	21.32	69932.	-1.3	-1.2	1.7	43.8	-6.	.000	-57.3	215.9	-.5	47,090	75.997	.1475-03	294.65

LOKI PARACHUTE NUMBER U042 LAUNCHED 25 SEP 81 1630 FROM SMR, AS IR, N M
STATION LATITUDE 32.467 LONGITUDE 106.417 ALTITUDE 1215.906 METERS RADAR 114
GEOMETRIC ALTITUDES
WIND DATA AVERAGED OVER 2 KM LAYER

THERMODYNAMIC DATA FOR KILOMETER LEVELS
BASE LEVEL PRESSURE 25.30 MB, ROCKET TEMPERATURE-52.42 RAOB TEMPERATURE-52.20
GEOMETRIC ALTITUDE 25299. METERS GEOPOTENTIAL 25187. METERS

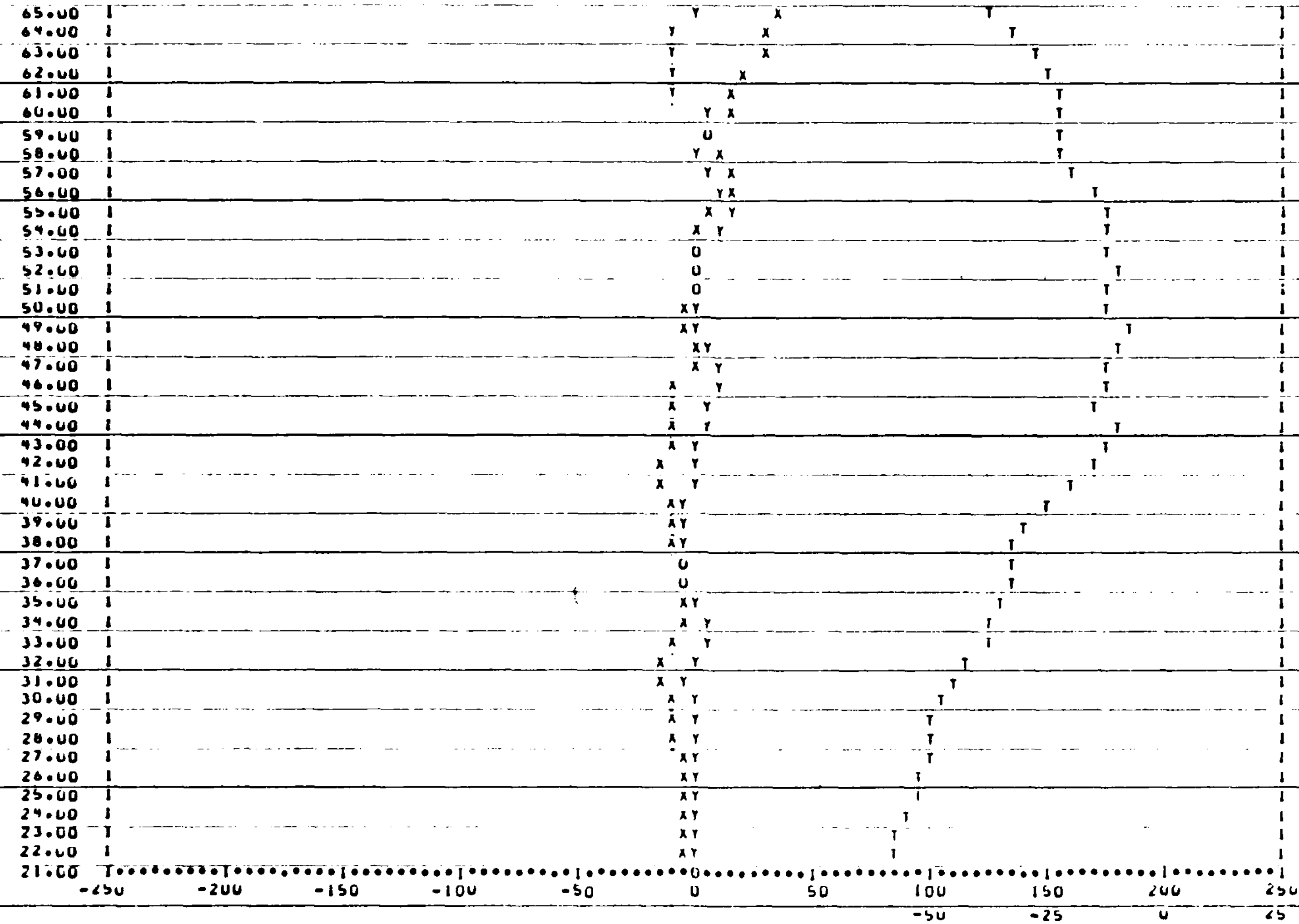
TIME	ALTITUDE (MSL)		WIND VELOCITY (M/SEC)			WIND DIRECTION	FALL VELOCITY	WIND SHEAR	TEMPERATURE (DEGREES)		CORR.	PRESSURE	DENSITY		SPEED OF SOUND
(SEC)	(KM)	(FEET)	-N+S	-E+W	TOTAL	(DEGREES)	(M/SEC)	(MPS/M)	(CENT)	(KEL)		(MB)	(GRAMS/ CU.M.)	(SLUGS/ CU.FT.)	(M/SEC)
159.3	65.00	213255.	-2.3	33.3	33.4	273.9	-131.	.008	-36.5	236.6	-12.2	.112	.164	.3192-06	308.48
167.0	64.00	209974.	-9.4	30.1	31.6	287.4	-125.	.001	-31.8	241.4	-10.6	.129	.185	.3599-06	311.59
175.2	63.00	206693.	-9.1	29.6	31.0	287.1	-119.	.011	-27.5	245.7	-9.6	.147	.209	.4057-06	314.34
183.8	62.00	203412.	-9.8	18.4	20.8	298.1	-112.	.002	-24.6	248.5	-9.0	.169	.237	.4593-06	316.15
193.0	61.00	200131.	-8.1	16.7	18.5	295.9	-106.	.012	-23.7	249.5	-8.4	.193	.270	.5233-06	316.76
202.8	60.00	196850.	4.3	15.1	15.7	254.2	-99.	.012	-22.4	250.8	-7.4	.221	.307	.5953-06	317.57
213.2	59.00	193570.	3.4	3.1	4.6	222.1	-92.	.006	-21.6	251.6	-6.8	.252	.349	.6781-06	318.08
224.5	58.00	190289.	-1.0	7.6	7.6	277.3	-86.	.008	-22.7	250.4	-5.8	.288	.401	.7785-06	317.36
236.4	57.00	187008.	4.2	13.4	14.0	252.5	-82.	.008	-19.3	253.9	-4.6	.329	.452	.8771-06	319.56
249.0	56.00	183727.	12.3	12.7	17.7	225.8	-77.	.009	-15.6	257.5	-4.0	.376	.508	.9860-06	321.82
262.4	55.00	180446.	16.9	4.4	17.5	194.5	-72.	.011	-12.5	260.7	-3.8	.428	.571	.1109-05	323.80
276.8	54.00	177165.	7.9	-2.4	8.2	163.3	-67.	.007	-12.5	260.7	-3.6	.486	.650	.1261-05	323.78
292.2	53.00	173885.	1.7	.4	1.7	193.3	-63.	.001	-11.9	261.3	-3.1	.553	.737	.1431-05	324.16
308.4	52.00	170604.	2.3	.8	2.4	200.4	-59.	.002	-10.2	262.9	-2.9	.629	.833	.1616-05	325.18
325.9	51.00	167323.	1.4	-1.1	1.8	141.6	-55.	.003	-11.6	261.5	-2.8	.715	.952	.1847-05	324.33
344.9	50.00	164042.	-1.2	-3.0	3.2	67.5	-52.	.001	-12.7	260.5	-2.3	.813	1.087	.2109-05	323.68
365.3	49.00	160761.	-.8	-2.6	2.7	73.9	-47.	.005	-7.8	265.3	-1.9	.924	1.213	.2353-05	326.67
387.2	48.00	157480.	3.7	-1.4	3.9	158.7	-44.	.004	-9.0	264.2	-2.0	1,049	1.383	.2684-05	325.96
410.6	47.00	154199.	7.8	-.1	7.8	179.6	-42.	.009	-11.4	261.8	-2.0	1,192	1.586	.3078-05	324.49
434.4	46.00	150919.	9.1	-8.8	12.6	136.0	-41.	.004	-13.7	259.5	-1.8	1,356	1.821	.3533-05	323.06
459.8	45.00	147638.	5.7	-11.2	12.5	116.8	-38.	.002	-14.1	259.0	-1.5	1,544	2.077	.4030-05	322.75
487.1	44.00	144357.	3.8	-9.5	10.2	111.9	-35.	.005	-11.2	262.0	-1.3	1,757	2.337	.4534-05	324.59
517.1	43.00	141076.	-.8	-10.7	10.7	85.6	-32.	.003	-11.3	261.9	-1.4	1,998	2.656	.5158-05	324.53
549.8	42.00	137795.	-2.0	-13.7	13.9	81.8	-30.	.001	-16.1	257.0	-1.4	2,275	3.084	.5984-05	321.53
584.4	41.00	134514.	-1.5	-14.4	14.4	83.9	-28.	.005	-20.9	252.3	-1.3	2,597	3.587	.6959-05	318.54
622.3	40.00	131234.	-4.2	-10.5	11.3	67.9	-25.	.003	-26.0	247.2	-1.2	2,973	4.190	.8131-05	315.28
663.2	39.00	127953.	-6.2	-8.9	10.8	54.8	-24.	.001	-30.9	242.3	-1.1	3,412	4.906	.9519-05	312.17
707.6	38.00	124672.	-5.8	-8.2	10.0	54.9	-22.	.002	-33.5	239.6	-1.0	3,925	5.706	.1107-04	310.44
755.4	37.00	121391.	-7.4	-6.4	9.8	40.9	-20.	.003	-33.3	239.9	-.9	4,518	6.562	.1273-04	310.59
807.1	36.00	118110.	-7.3	-3.8	8.2	27.6	-18.	.006	-33.5	239.7	-.8	5,201	7.561	.1467-04	310.46
863.6	35.00	114829.	-1.7	-3.1	3.5	60.4	-17.	.007	-35.4	237.8	-.8	5,991	8.777	.1703-04	309.26
924.4	34.00	111549.	4.0	-6.3	7.5	122.8	-16.	.004	-37.2	236.0	-.8	6,909	10.199	.1979-04	308.08
988.8	33.00	108268.	4.5	-10.5	11.5	113.1	-15.	.005	-37.2	235.9	-.7	7,973	11.772	.2284-04	308.04
1061.6	32.00	104987.	-.3	-12.9	12.9	88.9	-13.	.004	-41.3	231.8	-.7	9,212	13.845	.2686-04	305.34
1141.9	31.00	101706.	-4.0	-12.7	13.3	72.7	-12.	.003	-44.8	228.4	-.7	10,670	16.278	.3158-04	303.06
1223.3	30.00	98425.	-2.5	-10.3	10.6	76.4	-12.	.002	-47.6	225.5	-.6	12,385	19.131	.3712-04	301.17
1315.1	29.00	95144.	-.4	-9.9	9.9	87.4	-10.	.002	-49.7	223.5	-.6	14,399	22.448	.4356-04	299.79
1415.0	28.00	91864.	-1.7	-8.9	9.0	79.4	-10.	.002	-49.5	223.7	-.6	16,752	26.090	.5062-04	299.94
1519.4	27.00	88583.	-1.6	-6.5	6.7	76.4	-9.	.001	-50.9	222.3	-.6	19,498	30.559	.5930-04	299.00
1635.8	26.00	85302.	-.9	-6.1	6.2	82.1	-8.	.001	-52.3	220.9	-.5	22,717	35.829	.6952-04	298.06
1761.5	25.00	82021.	-1.4	-5.2	5.4	75.0	-8.	.002	-53.1	220.1	-.5	26,490	41.937	.8137-04	297.49
1899.7	24.00	78740.	.2	-3.4	3.5	93.6	-7.	.001	-55.1	218.1	-.5	30,920	49.388	.9583-04	296.17
2048.5	23.00	75459.	1.1	-4.1	4.3	105.2	-6.	.002	-56.5	216.7	-.5	36,137	58.098	.1127-03	295.21
2213.8	22.00	72178.	-.9	-3.5	3.6	75.0	-6.	.003	-57.9	215.3	-.5	42,279	68.425	.1328-03	294.23
2398.6	21.00	68898.	-1.1	-.5	1.2	23.8	-6.	.000	9999999999999999999999999999999999999999999999999						

LOKI PARACHUTE NUMBER 0042 LAUNCHED 25 SEP 81 1630 FROM SMR, WSMR, N M
STATION LATITUDE 32.467 LONGITUDE 106.417 ALTITUDE 1215.906 METERS RADAR 114
GEOMETRIC ALTITUDES

ROCOB MESSAGE

21999	02001	99999	22558	07004	91684
23556	11004	91581	24555	09003	91494
25553	08005	91419	26552	08006	91358
27551	08007	91306	28549	08009	91261
29550	09010	91224	30548	08011	91191
31545	07013	91163	32541	09013	91138
33537	11011	91118	34537	12007	91102
35535	06009	92878	36539	03008	92756
37533	04010	92656	38534	05010	92571
39531	05011	92491	40526	07011	92419
41521	08014	92359	42516	08014	92308
43511	09011	92266	44511	11010	92234
45514	12013	92208	46514	14013	92162
47511	18008	92159	48509	16004	92138
49508	07003	92121	50513	07003	92109
51512	14002	93952	52510	20002	93833
53512	19002	93737	54512	16008	93650
55512	19017	93571	56516	23018	93508
57519	25014	93452	58523	28008	93401
59522	22005	93349	60522	25016	93307
61524	30019	93270	62525	30021	93237
63527	29031	93209	64532	29032	93185
65537	27033	93164			

X AND Y WIND(M/SEC) AND TEMPERATURE(DEG C) VS. ALTITUDE(KM)



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MRN FORMATTED DATA CARDS LOKI PARACHUTE      0042 25 SEP 81 1630 R-114
 STA  DATE TIME ALT DIR SP          NS  EW FV TMP COR  PRES   DEN  S/S
72269810925163006557271039         -001 039132-039-131,030-11.535-1307     30
72269810925163006500274033         -002 033131-037-121,117-11.645-1308     30
72269810925163006400267032         -009 030125-032-111,285-11.855-1312     30
72269810925163006300287031         -009 030119-027-101,474-12.091-1314     30
72269810925163006232292024         -009 023114-025-091,617-12.269-1316     30
72269810925163006200298021         -010 018112-025-091,688-12.367-1316     30
72269810925163006100296019         -008 017106-024-081,931-12.697-1317     30
72269810925163006000254016          004 015099-022-072,205-13.068-1316     30
72269810925163005900222005          003 003092-022-072,524-13.495-1318     30
72269810925163005884223003          002 002091-021-072,579-13.566-1318     30
72269810925163005800277008         -001 008086-023-062,884-14.012-1317     30
72269810925163005787275009         -001 009086-023-052,934-14.080-1317     30
72269810925163005700252014          004 013082-019-053,294-14.520-1320     30
72269810925163005600226018          012 013077-016-043,756-15.082-1322     30
72269810925163005500194017          017 004072-012-044,276-15.714-1324     30
72269810925163005481183016          016 001071-012-044,379-15.836-1324     30
72269810925163005400163008          008-002067-014-049,863-16.500-1324     30
72269810925163005340176004          004 000065-013-035,255-17.033-1324     30
72269810925163005300193002          002 000063-012-035,531-17.374-1324     30
72269810925163005219224002          001 001060-010-036,173-18.174-1325     30
72269810925163005200200002          002 001059-010-036,287-18.330-1325     30
72269810925163005100142002          001-001055-012-037,146-19.519-1324     30
72269810925163005000067003         -001-003052-013-028,128-11.087+0324     30
72269810925163004985051004         -003-003051-013-028,289-11.110+0324     30
72269810925163004900074003         -001-003047-008-029,237-11.213+0327     30
72269810925163004883103002          001-002047-007-029,444-11.236+0327     30
72269810925163004800159004          004-001044-009-021,049+01.383+0326     30
72269810925163004700180008          008 000042-011-021,192+01.586+0324     30
72269810925163004600136013          009-009091-014-021,356+01.821+0323     30
72269810925163004522120013          006-011039-015-021,501+02.029+0322     30
72269810925163004500117013          006-011038-014-021,544+02.077+0323     30
72269810925163004454116012          005-011037-012-011,635+02.182+0324     30
72269810925163004400112010          004-010035-011-011,757+02.337+0325     30
72269810925163004313085010         -001-010032-011-011,965+02.608+0325     30
72269810925163004300086011         -001-011032-011-011,998+02.658+0325     30
72269810925163004200082014         -002-014030-016-012,275+03.084+0322     30
72269810925163004100084014         -002-014028-021-012,597+03.587+0319     30
72269810925163004060060011         -002-011027-023-012,739+03.810+0317     30
72269810925163004000068011         -004-010025-026-012,973+04.190+0315     30
72269810925163003963060011         -006-010025-028-013,126+04.442+0314     30
72269810925163003900055011         -006-009024-031-013,412+04.906+0312     30
72269810925163003839056010         -006-009022-034-013,715+05.403+0310     30
72269810925163003800055010         -006-008022-034-013,925+05.706+0310     30
72269810925163003700041010         -007-006020-033-014,516+06.562+0311     30
72269810925163003619029009         -008-004019-033-015,063+07.349+0311     30
72269810925163003600028008         -007-004018-034-015,201+07.561+0310     30
72269810925163003500060004         -002-003017-035-015,991+08.777+0309     30
72269810925163003401123007          004-006016-037-016,902+01.019+1308     30
72269810925163003400123007          004-006016-037-016,904+01.020+1308     30
72269810925163003300113011          005-011015-037-017,973+01.17[illegible] 1308     30
72269810925163003248111012          004-011014-037-018,107+01.197+1308     30
72269810925163003200089013          006-013013-043-019,212+01.384+1305     30
72269810925163003167084014         -001-014013-043-019,67[illegible]+01.463+1304     30
72269810925163003100073013         -004-013012-045-011,06[illegible]+11.526+1303     30
7226981092516[illegible]00075011         -002-010012-048-011,23[illegible]+11.413+13[illegible]     30
```

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72269810925163002919084010     -001-010011-050-011,398+12.182+1300     30
72269810925163002900087010      000-010010-050-011,440+12.245+1300     30
72269810925163002835081010     -002-010010-049-011,588+12.468+1300     30
72269810925163002800079009     -002-009010-049-011,675+12.609+1300     30
72269810925163002700076007     -002-007009-051-011,950+13.056+1299     30
72269810925163002600082006     -001-006008-052-012,272+13.583+1298     30
72269810925163002568081006     -001-006008-053-012,386+13.772+1298     30
72269810925163002530077006     -001-006008-053-012,530+14.002+1298     30
72269810925163002500075005     -001-005008-053-012,649+14.194+1297     30
72269810925163002448072004     -001-004007-053-012,869+14.549+1297     30
72269810925163002400094003      000-003007-055-013,092+14.939+1296     30
72269810925163002360104004      001-004007-056-013,288+15.285+1295     30
72269810925163002300105004      001-004006-056-013,614+15.810+1295     30
72269810925163002264107004      001-004006-057-013,823+16.147+1295     30
72269810925163002231094004      000-004006-059-014,024+16.532+1294     30
72269810925163002200075004     -001-003006-058-014,228+16.842+1294     30
72269810925163002132044002     -001-001006-057 004,709+17.600+1295     30
72269810925163002100024001     -001 0000069999999999999999999999999     30
```

LOKI PARACHUTE NUMBER UC42 LAUNCHED 25 SEP 81 1630 FROM SMR, WS-R, N M
STATION LATITUDE 32.467 LONGITUDE 106.417 ALTITUDE 1215.906 METERS RADAR 114
GEOMETRIC ALTITUDES
WIND DATA AVERAGED OVER 2 KM LAYER

THERMODYNAMIC DATA FOR 5000 FEET LEVELS
BASE LEVEL PRESSURE 25.30 MB, ROCKET TEMPERATURE-52.42 RAOB TEMPERATURE-52.20
GEOMETRIC ALTITUDE 25299. METERS GEOPOTENTIAL 25187. METERS

TIME	ALTITUDE (MSL)		WIND VELOCITY (M/SEC)			WIND DIRECTION	FALL VELOCITY	WIND SHEAR	TEMPERATURE (DEGREES)		CORR.	PRESSURE	DENSITY (GRAMS/	(SLUGS/	SPEED OF SOUND
(SEC)	(KM)	(FEET)	-N+S	-E+W	TOTAL	(DEGREES)	(M/SEC)	(MPS/M)	(CENT)	(KEL)		(MB)	CU.M.)	CU.FT.)	(M/SEC)
155.3	65.53	215000.	-1.0	39.0	39.0	271.4	-132.	.008	-39.1	234.0	-13.1	.104	.154	.2990-06	306.78
167.0	64.01	210000.	-9.2	30.1	31.4	287.0	-126.	.003	-31.8	241.3	-10.7	.128	.185	.3594-06	311.53
179.6	62.48	205000.	-8.9	24.9	26.4	289.6	-115.	.006	-25.5	247.7	-9.3	.158	.222	.4314-06	315.60
193.4	60.96	200000.	-7.3	16.6	18.2	293.7	-105.	.011	-23.5	249.6	-8.2	.194	.271	.5255-06	316.86
208.6	59.44	195000.	5.1	6.2	8.0	230.8	-95.	.004	-22.0	251.2	-7.1	.238	.330	.6405-06	317.82
225.5	57.91	190000.	-.7	8.9	8.9	274.7	-86.	.007	-22.8	250.4	-5.6	.292	.406	.7876-06	317.35
244.0	56.39	185000.	8.2	13.8	16.0	239.2	-79.	.009	-17.0	256.1	-4.2	.357	.486	.9422-06	320.95
264.3	54.86	180000.	16.5	1.9	16.6	186.7	-71.	.009	-12.0	261.1	-3.8	.435	.580	.1126-05	324.06
286.9	53.34	175000.	3.2	-.2	3.2	176.5	-65.	.000	-12.7	260.4	-3.3	.529	.708	.1374-05	323.63
311.6	51.82	170000.	3.3	.5	3.3	188.6	-59.	.002	-10.5	262.7	-2.9	.644	.854	.1657-05	325.03
339.2	50.29	165000.	.4	-1.7	1.7	102.2	-53.	.000	-12.3	260.8	-2.4	.783	1.046	.2029-05	323.89
370.2	48.77	160000.	.5	-2.2	2.3	103.1	-47.	.004	-7.0	266.1	-2.0	.951	1.245	.2415-05	327.15
404.8	47.24	155000.	6.2	-.5	6.2	175.8	-43.	.007	-10.8	262.4	-2.0	1.154	1.533	.2974-05	324.84
441.3	45.72	150000.	8.3	-10.9	13.7	127.4	-40.	.002	-14.2	258.9	-1.7	1.405	1.891	.3669-05	322.69
481.6	44.20	145000.	5.1	-10.2	11.4	116.8	-36.	.005	-11.4	261.8	-1.4	1.712	2.278	.4420-05	324.46
527.7	42.67	140000.	-2.8	-12.4	12.7	77.4	-31.	.002	-12.9	260.3	-1.3	2.084	2.788	.5411-05	323.56
579.1	41.15	135000.	-1.5	-15.1	15.2	84.2	-28.	.004	-20.2	253.0	-1.3	2.545	3.505	.6800-05	318.98
637.3	39.62	130000.	-5.5	-9.6	11.1	60.2	-25.	.001	-28.0	245.2	-1.2	3.128	4.445	.8625-05	314.01
703.1	38.10	125000.	-5.7	-8.5	10.2	56.4	-22.	.003	-33.6	239.6	-1.0	3.867	5.623	.1091-04	310.42
777.1	36.58	120000.	-8.5	-5.6	10.2	33.5	-19.	.005	-33.2	239.9	-.9	4.792	6.959	.1350-04	310.64
860.4	35.05	115000.	-2.0	-2.9	3.5	55.4	-17.	.006	-35.2	237.9	-.8	5.944	8.704	.1689-04	309.33
953.7	33.53	110000.	5.5	-7.8	9.5	125.2	-15.	.005	-37.2	236.0	-.8	7.387	10.905	.2116-04	308.06
1061.3	32.00	105000.	-.3	-12.9	12.9	88.9	-13.	.002	-41.3	231.8	-.7	9.206	13.833	.2684-04	305.35
1183.7	30.48	100000.	-3.5	-11.1	11.6	72.5	-12.	.002	-46.3	226.9	-.7	11.525	17.695	.3434-04	302.08
1319.4	28.96	95000.	-.5	-10.0	10.1	87.2	-10.	.002	-49.6	223.5	-.6	14.489	22.584	.4382-04	299.82
1473.1	27.43	90000.	-1.7	-7.4	7.6	77.5	-9.	.001	-50.3	222.9	-.6	18.256	28.533	.5537-04	299.40
1646.7	25.91	85000.	-1.0	-6.1	6.1	81.1	-8.	.002	-52.4	220.8	-.5	23.037	36.354	.7054-04	297.97
1845.4	24.38	80000.	-1.1	-3.7	3.8	72.7	-7.	.002	-53.7	219.4	-.5	29.127	46.245	.8973-04	297.06
2071.2	22.86	75000.	1.3	-4.1	4.3	107.5	-6.	.002	-56.5	216.7	-.5	36.912	59.347	.1152-03	295.20
2328.2	21.34	70000.	-1.3	-1.3	1.9	45.2	-6.	.000	-57.3	215.8	-.5	46.874	75.657	.1468-03	294.53

LOKI PARACHUTE NUMBER U042 LAUNCHED 25 SEP 81 1630 FROM SMR, WSMR, N M
STATION LATITUDE 32.467 LONGITUDE 106.417 ALTITUDE 1215.906 METERS RADAR 114
GEOMETRIC ALTITUDES
WIND DATA AVERAGED OVER 2 KM LAYER

THERMODYNAMIC DATA FOR MANDATORY (CONSTANT PRESSURE) LEVELS
BASE LEVEL PRESSURE 25.30 MB, ROCKET TEMPERATURE-52.42 RAOB TEMPERATURE-52.20
GEOMETRIC ALTITUDE 25299. METERS GEOPOTENTIAL 25187. METERS

TIME	ALTITUDE (MSL)		WIND VELOCITY (M/SEC)			WIND DIRECTION	FALL VELOCITY	WIND SHEAR	TEMPERATURE (DEGREES)		CORR.	PRESSURE	DENSITY (GRAMS/	(SLUGS/	SPEED OF SOUND	
(SEC)	(KM)	(FEET)	-N+S	-E+W	TOTAL	(DEGREES)	(M/SEC)	(MPS/M)	(CENT)	(KEL)		(MB)	CU.M.)	CU.FT.)	(M/SEC)	GEOPOT. ALT(KM)
195.6	60.73	199261.	-4.8	17.6	18.3	285.1	-103.	.003	-23.6	249.6	-8.3	.200	.279	.5417-06	316.82	60.13
228.0	57.70	189309.	.1	10.8	10.8	269.3	-85.	.007	-22.2	251.0	-5.4	.300	.416	.8079-06	317.73	57.16
255.6	55.50	182103.	15.9	10.0	18.8	212.1	-74.	.009	-14.1	259.0	-3.9	.400	.538	.1044-05	322.77	55.00
280.0	53.78	176455.	5.9	-1.8	6.2	162.9	-66.	.002	-12.6	260.6	-3.5	.500	.668	.1297-05	323.73	53.31
323.0	51.16	167860.	1.7	-1.4	2.2	139.7	-55.	.000	-11.2	262.0	-2.6	.700	.931	.1806-05	324.59	50.73
378.6	48.38	158734.	2.5	-2.1	3.2	140.3	-45.	.002	-8.0	265.2	-2.0	1,000	1.314	.2549-05	326.57	47.99
517.2	43.00	141062.	-1.6	-10.6	10.7	81.6	-32.	.001	-11.3	261.9	-1.4	2,000	2.661	.5163-05	324.53	42.69
625.0	39.93	131013.	-4.2	-10.5	11.3	67.9	-25.	.002	-26.3	246.8	-1.2	3,000	4.234	.8215-05	315.08	39.66
792.4	36.28	119026.	-8.3	-4.8	9.6	30.0	-19.	.005	-33.2	240.0	-.9	5,000	7.259	.1409-04	310.66	36.06
930.0	33.91	111248.	4.1	-6.5	7.7	122.2	-16.	.004	-37.2	236.0	-.8	7,000	10.334	.2005-04	308.07	33.71
1105.8	31.44	103159.	-2.4	-13.8	14.0	80.0	-13.	.002	-43.5	229.6	-.7	10,000	15.171	.2944-04	303.90	31.27
1537.5	26.84	88053.	-1.2	-6.3	6.4	79.1	-9.	.001	-51.1	222.1	-.5	20,000	31.377	.6088-04	298.84	26.71
1872.0	24.19	79377.	-.5	-3.4	3.5	81.6	-7.	.000	-54.4	218.8	-.5	30,000	47.773	.9270-04	296.62	24.09

```
MRN FORMATTED DATA CARDS LOKI PARACHUTE      0042 25 SEP 81 1630 R-114
 STA  DATE TIME ALT DIR SP           NS  EA FV TMP COR  PRES   DEN  S/S
72269810925163006013285018          -005 018   -024-082,000-12.792-1317          40
72269810925163005716269011           000 011   -022-053,000-14.164-1318          40
72269810925163005500212019           016 010   -014-044,000-15.380-1323          40
72269810925163005331163006           006-002   -013-035,000-16.685-1324          40
72269810925163005073140002           002-001   -011-037,000-19.309-1325          40
72269810925163004799140003           002-002   -008-021,000+01.314+0327          40
72269810925163004269082011          -002-011   -011-012,000+02.661+0325          40
72269810925163003966068011          -004-010   -026-013,000+04.234+0315          40
72269810925163003606030010          -008-005   -033-015,000+07.259+0311          40
72269810925163003371122008           004-006   -037-017,000+01.033+1308          40
72269810925163003127080014          -002-014   -044-011,000+11.517+1304          40
72269810925163002671079006          -001-006   -051-012,000+13.138+1299          40
72269810925163002409082003          -001-003   -054-013,000+14.777+1297          40

*BRKPT PRINTS
```

XI. TAPE UNIT ASSIGNMENTS

INPUT TAPES

1. UNILOG Tape - radar data recorded on a digital tape using a real-time log routine on the UNIVAC 1108. The UNILOG Tape is assigned to Fortran logical unit 2 and is read by the system subroutine FLDTAP.

Each physical record contains data for a one-second interval and begins with the first message after the whole second. The data rate is 20 messages per second. The record length is variable.

Each physical record contains a control word and 20 logical records. The control word should be ignored. Each logical record contains a word count and a time word, which are followed by five words of information for each active input. The maximum number of inputs is 32. Therefore, the maximum size of a physical record is 3241 words (1 + (20* (2 + (32*5)))). If no inputs are active, each logical record will contain only a word count (equal to one) and a time word. The minimum size of a physical record is, therefore, 41 words (1 + (20*(2))).

The time word is floating-point range time in milliseconds. The five data words for each input contain information from the standard serial data format. The IOMUX input subchannel number appears in the second sixth-word (second most significant character) in the second data word of each five-word input data block. This number has a value from zero to 31. An example of a physical record containing radar data is on the following page.

UNILOG TAPE FORMAT

CONTROL WORD	35 … 0	
WORD COUNT		(ELEVEN) 11
TIME WORD		FLOATING POINT MILLISECONDS
DATA WORD 1	35 33, 32 30, 29 24, 23 16, 15 9, 8 5, 0	Run # | TGT # | C C | SYNC | ID | 000 | T M
DATA WORD 2	29 24, 23 … 0	S/C #* | RANGE LSB
DATA WORD 3	23 … 0	MSB AZIMUTH
DATA WORD 4	23 … 0	MSB ELEVATION
DATA WORD 5	23 … 0	RANGE RATE LSB
DATA WORD 1	35 33, 32 30, 29 24, 23 16, 15 9, 8 5, 0	RUN # | TGT # | C C | SYNC | ID | 000 | T M
DATA WORD 2	29 24, 23 … 0	S/C #* | RANGE LSB
DATA WORD 3	23 … 0	MSB AZIMUTH
DATA WORD 4	23 … 0	MSB ELEVATION
DATA WORD 5	23 … 0	RANGE RATE LSB

LOGICAL RECORD

PHYSICAL RECORD

19 more logical records

TGT # = Target Number

CC = Confidence Counter

ID = Site Identification

TM = Tracking Mode

* Subchannel Numbers will be in ascending order (0 - 31).

The range is in yards and the azimuth and elevation are in units equivalent to 4.7937×10^{-5} radians.

2. DR format tape - radar data recorded on a digital tape generated by processing the radar field tape. DR formatted tapes are assigned to Fortran logical unit 1. These tapes are BCD and contain information used by METRØC in the following format.

Character No	Format	
11-19	F9.3	Time (seconds from lift-off time)
51-59	F9.1	Slant range from radar (yards)
61-69	F9.2	Azimuth from radar (mils)
71-79	F9.2	Elevation from radar (mils)

3. The program METRØC may be written on a tape which is used in each run (see section on control cards).

Intermediate tapes Note: On the UNIVAC 1108, intermediate data may be written on magnetic drum rather than magnetic tape.

1. When a UNILØG tape is being processed and it contains data from two radars, the data from both radars may be reduced in a single run. In this case, when the data from the first radar is being processed, information from the second radar is being written on Fortran unit 3 in an unformatted mode.

Word	
1	Time (seconds from lift-off-time)
2	Slant range from radar (meters)
3	Azimuth from radar (radians)
4	Elevation from radar (radians)

2. In any run with wind data to be processed, the individual wind samples are recorded on Fortran logical unit 13 for use in obtaining averaged layer wind data. If the wind data is input on cards, the input data points are recorded. When the input is digital tape, data is computed and stored at one sample per second. These records are written in an unformatted mode.

Word

1 Time (seconds from lift-off time)

2 Altitude (meters)

3 Altitude (feet)

4 N-S wind component (meters/sec)

5 E-W wind component (meters/sec)

6 Wind speed (meters/sec)

7 Wind direction (degrees)

8 Fall velocity (meters/sec)

9 Number of points since last good point which were rejected as bad data.

Output tapes At present there are no output tapes being generated by METRØC.

OUTPUT LISTINGS

The output listings are in metric units, with additional listings in English units available as an option. The data consists of:

1. Wind Data
   - A. Individual wind samples
     1. One sample/second with digital tape input
     2. Input points with punch card input

B. Averaged wind data for even kilometer levels averaged over 2 kilometer layers.(When temperatures are included, the averaged winds are listed combined with the thermodynamic data.)

II. Thermodynamic Data

A. Type of data

1. Wind averaged over 2 kilometer layers
2. Temperatures
3. Pressure computed using hydrostatic equations, rocket temperatures, and base-level point from conjunctive raob
4. Computed density
5. Computed speed of sound

B. Types of levels for thermodynamic data

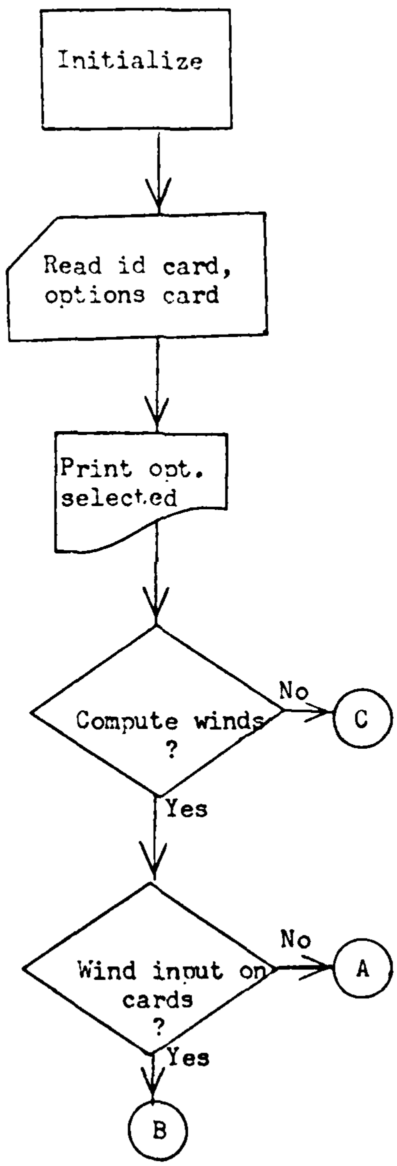
1. Significant temperature levels
2. Even kilometer or .5 kilometer levels
3. 5000 foot or 1000 foot levels
4. Mandatory (constant-pressure) levels

C. Types of listings output

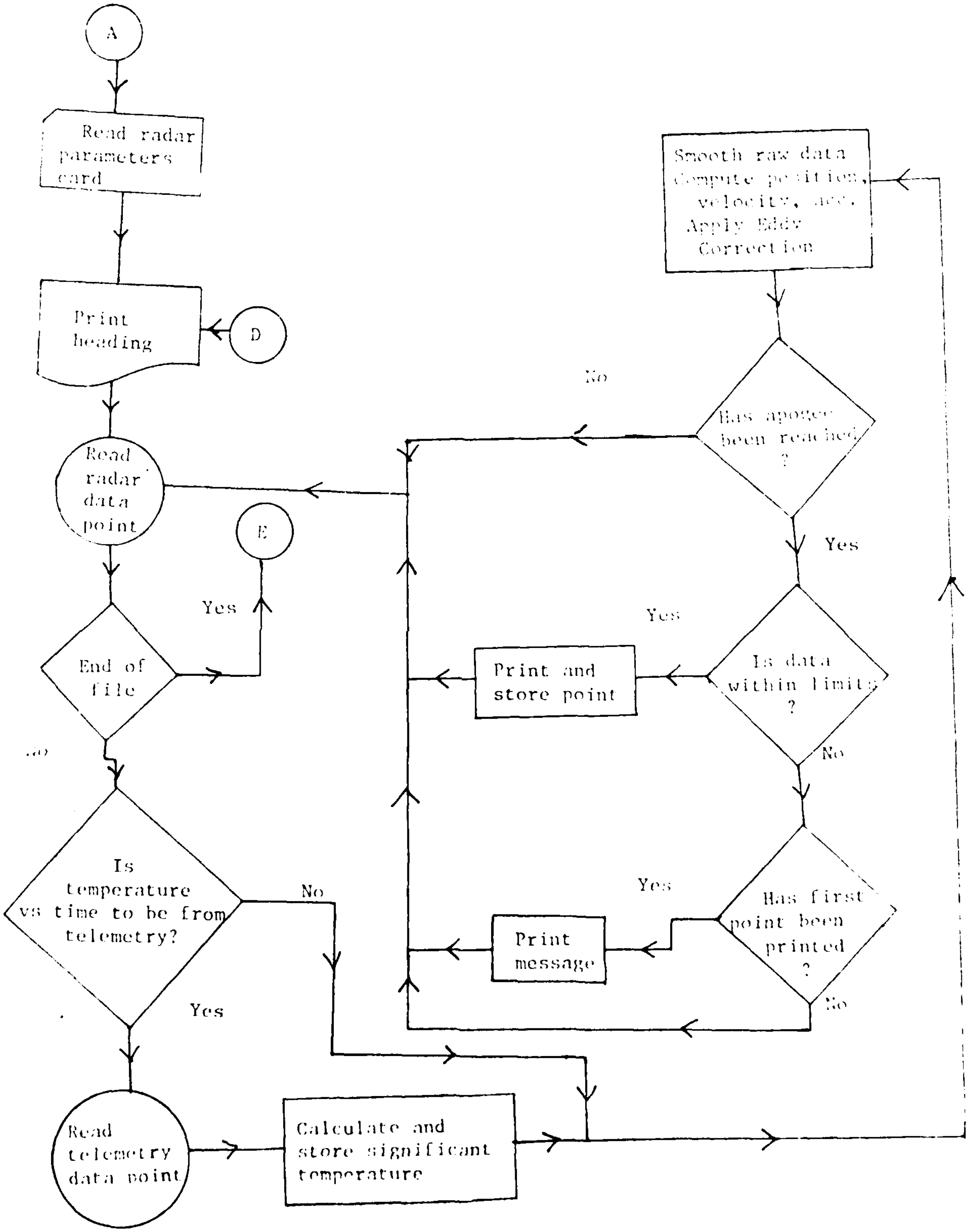
1. Standard data summary
2. MRN formatted data
3. Ozonesonde parameters (optional)
4. English units data (optional)

XII FLOWCHARTS OF OVERALL SYSTEM OPERATION

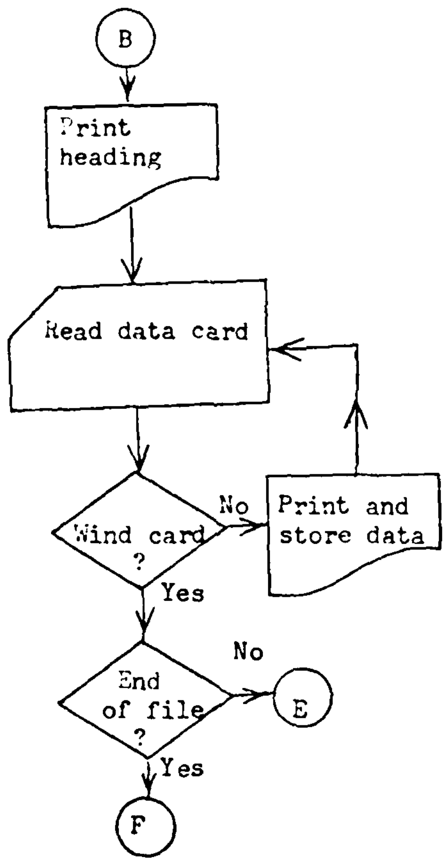
Initialization



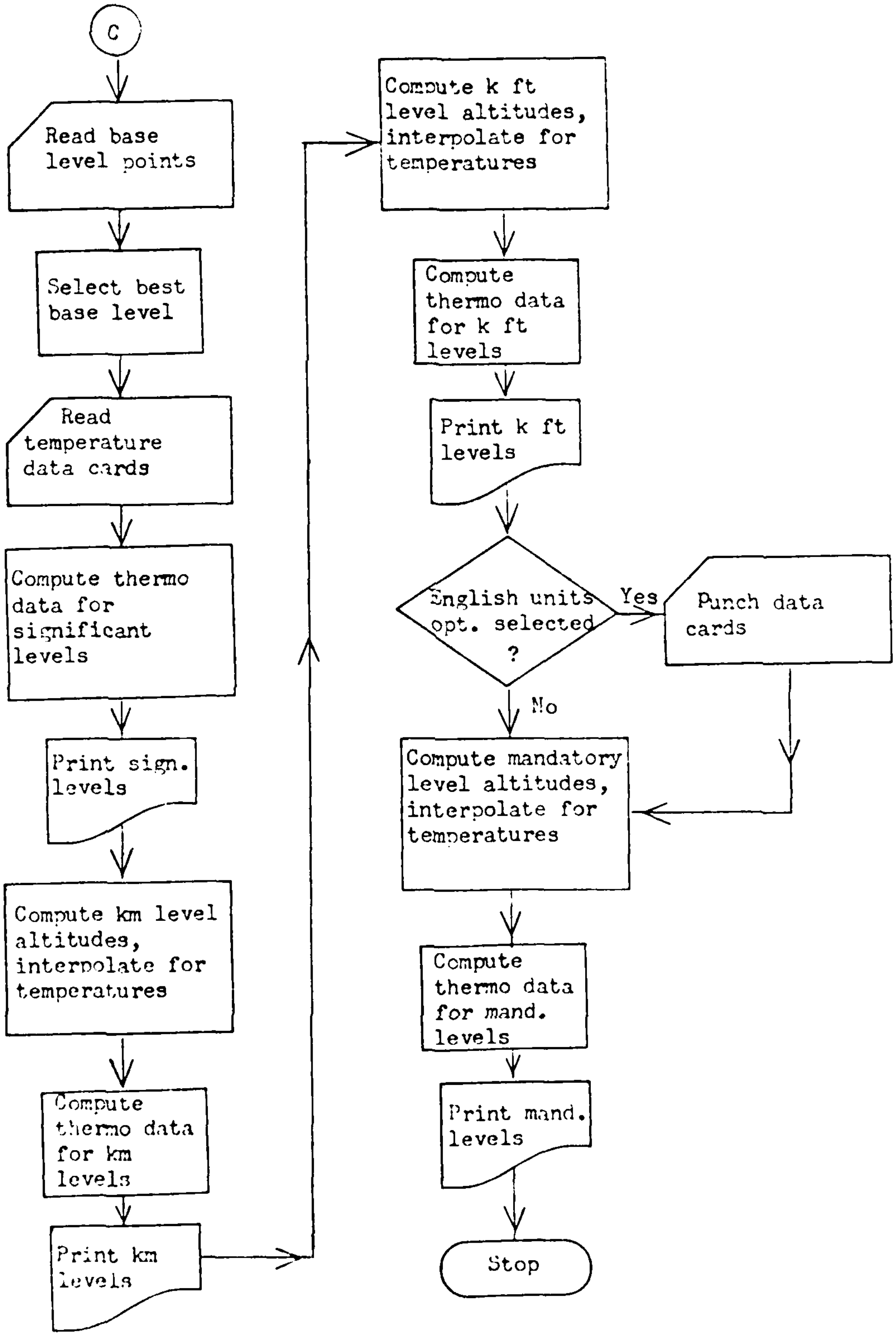
Radar Tape Processing



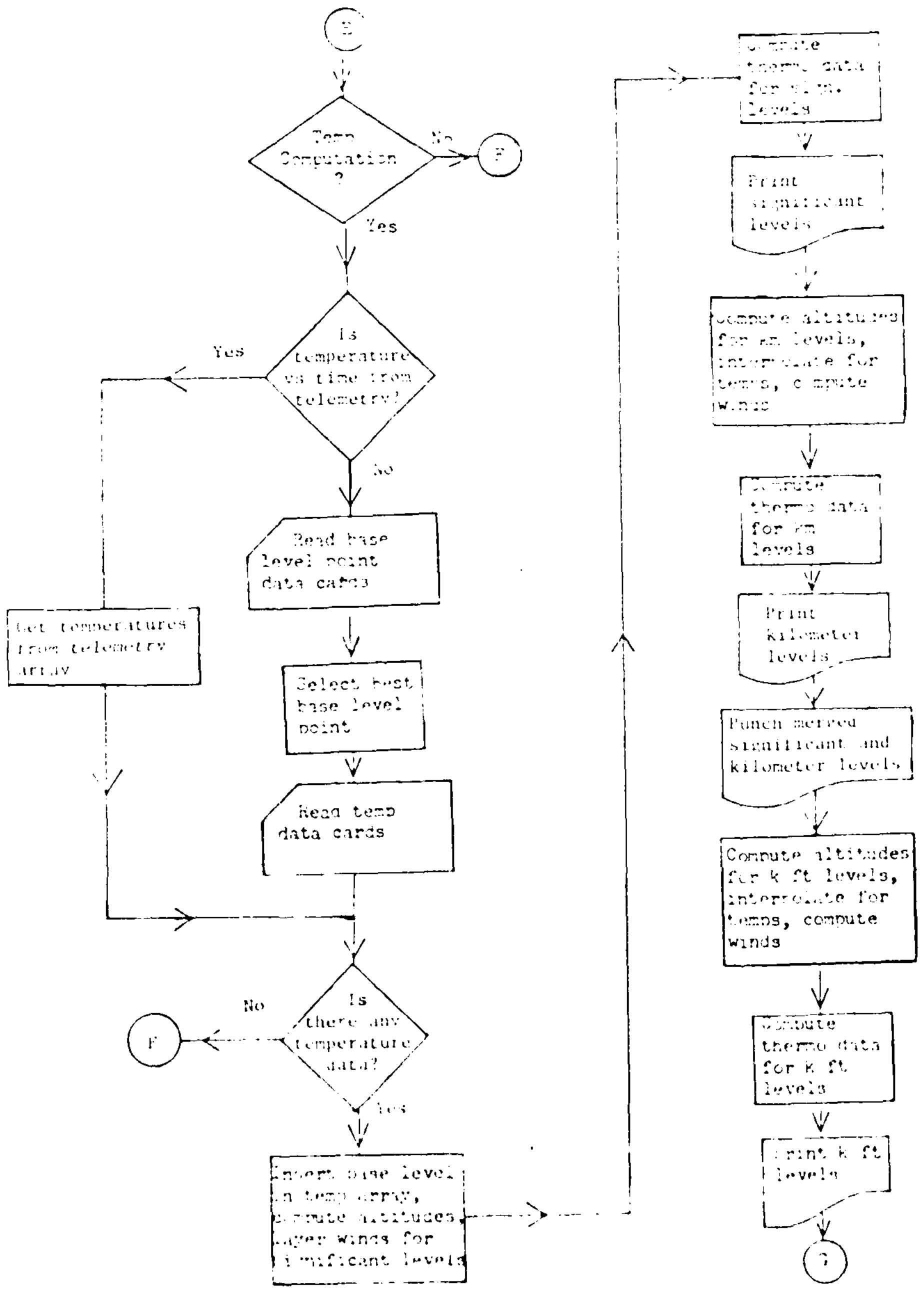
Wind Data Card Processing



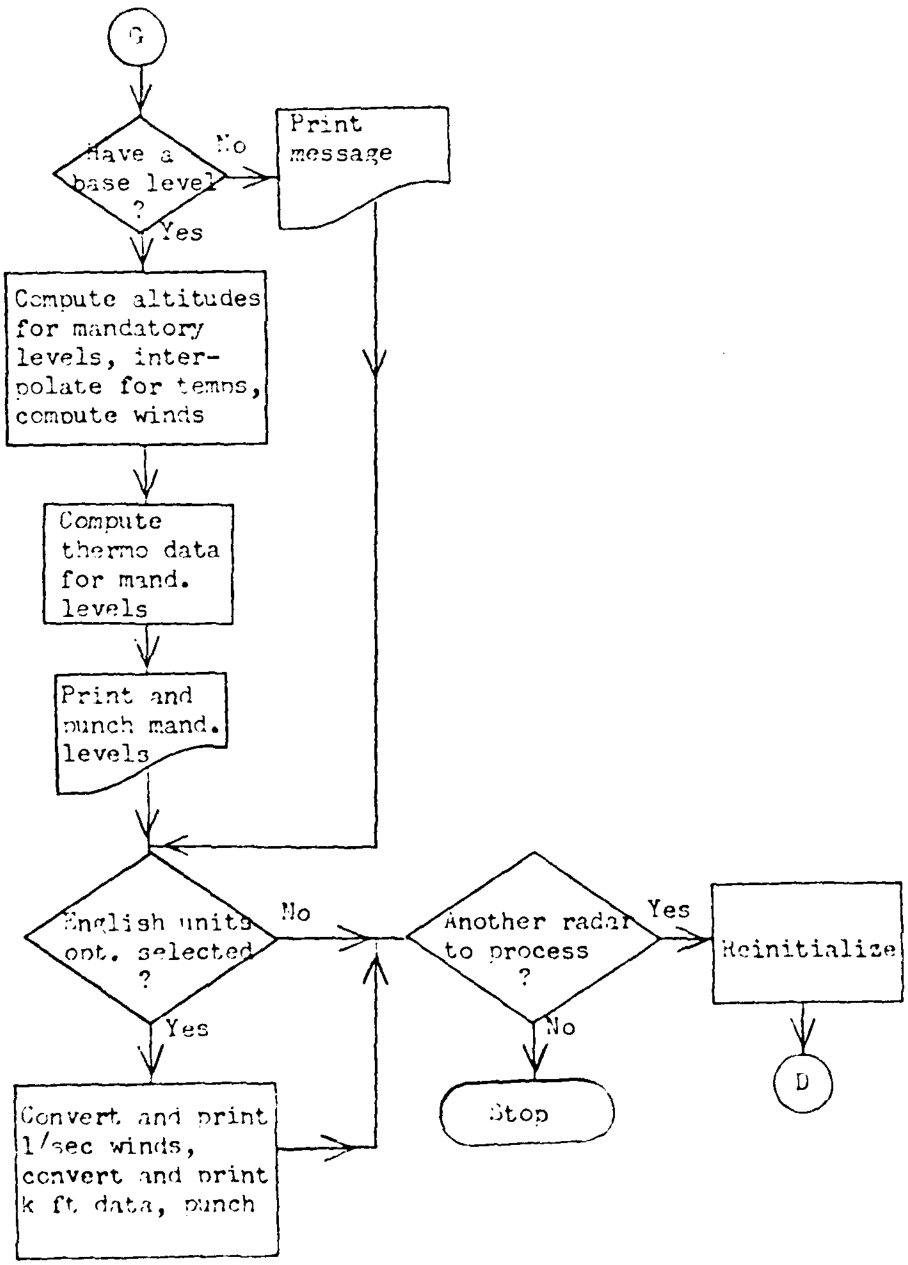
Temperatures Only Processing



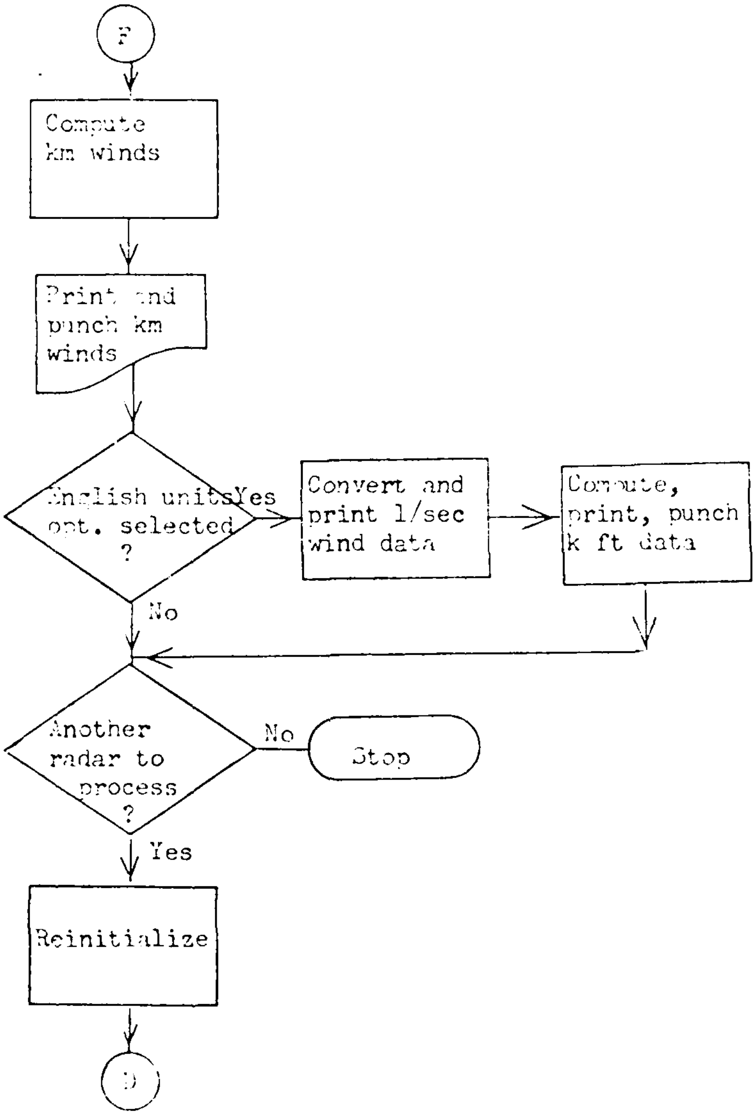
Temperature with Wind Processing



Temperature with Wind Processing (cont.)

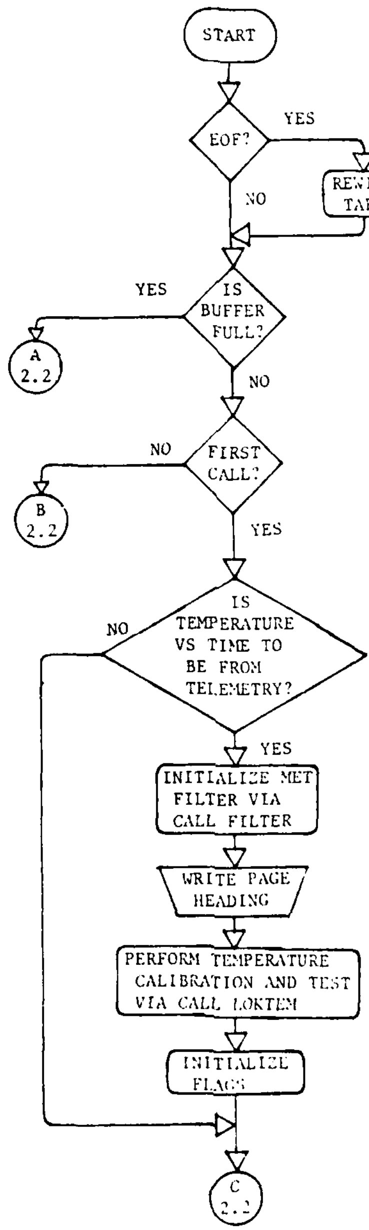


Kilometer Winds Processing



XIII FLOWCHARTS OF MODIFIED OR NEW PROGRAMS

FLOWCHART FOR SUBROUTINE RTDATA - 2.1



FLOWCHART FOR SUBROUTINE RTDATA - 2.2